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MiniReview

Sesame proteins

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Abstract

Sesame (*Sesamum indicm* L.) is one of the world's most important oil seed crops. Apart from being an important oilseed source, sesame seed is a potential source of proteins. This article is a review of sesame protein, including seed structure, chemical composition, extraction, characteristics, functional properties and modification of sesame protein. Sesame seed structure, chemical composition, sesame seed cross-section and proximate composition have also been reviewed. For sesame protein extraction, there are many reports on various methods including alkaline or salt extraction and isoelectric precipitation (pI) or aqueous extraction. For characteristics of sesame proteins, many studies have characterized the main proteins in sesame which are albumin and globulin. Some functional properties of sesame protein and the influence of various processing factors and conditions are also reviewed in the article. Lastly, the article reviews the proteolytic enzyme modification of proteins and shows that it is an effective way to improve the various functional properties of proteins and to increase the field of application of proteins.

Introduction

Sesame seed (*Sesamum indicm* L.) is an important oil seed crop. Sesame is grown in tropical zones as well as in temperate zones between latitudes 40°N and 40°S. It has been cultivated for centuries, especially in Asia and Africa. In 2009, the world production of sesame seed was 3,976,968 tons, and the major production area were Asia (2,489,518 tons) and Africa (1,316,690 tons), constituting about 62.6% and 33.1% of the total world production (FAOSTAT, 2011). Apart from being an important source of edible oil, sesame seeds and kernels are used for the preparation of sweets, confectionary and bakery products (Salunkhe *et al*., 1992).

Sesame seed contains 40-50% oil, 20-25% protein, 20-25% carbohydrate and 5-6% ash (Salunkhe *et al*., 1992). Because of its composition, it has become one of the main sources of edible oil. It is also a good source of protein. Some studies have already been done showing how to prepare sesame protein from sesame meal using various methods of alkaline or salt extraction and isoelectric precipitation (pI) (Dench *et al*., 1981; Rivas *et al*., 1981; Inyang and Iduh, 1996; Gandhi and Srivastava, 2007; Onsaard *et al*., 2010; Cano-Medina *et al*., 2011) or aqueous enzymatic sesame protein extraction (Latif and Anwar, 2011).

The work on sesame protein has mostly reported about solubility, extractability of the protein as a function of various extractability parameters, and isolation and characterization of protein components (Prakash and Nandi, 1978; Okubo *et al*., 1979; Rivas *et al*., 1981; De Padua, 1983; Rajendran and Prakash, 1988; Gandhi and Srivastava, 2007; Kanu *et al*., 2007; Orruño and Morgan, 2007; Onsaard *et al*., 2010). A few paper on the modification of sesame proteins have also reported (Bandyopadhyay and Ghosh, 2002; Das *et al*., 2009; Das *et al*., 2012).

In this paper, we will review sesame seed structure, chemical composition, extraction, characteristics, functional properties and modification of sesame protein.

Sesame seed structure

Sesame is an oilseed plant in the genus Sesamum and the family Pedaliceae. It is an annual plant growing to 50 to 100 cm in height, with opposite leaves 4 to 14 cm long with an entire margin; they are broad lanceolate, to 5 cm broad, at the base of the plant, narrowing to just 1 cm broad on the flowering stem. The flowers are white to purple, tubular, 3 to 5 cm long, with a four-lobed mouth (Salunkhe *et al*., 1992).

The fruit of sesame is a capsule that has 50-100 seeds. The sesame seeds are pear-shaped, overate, and small flatted. The dimensions of sesame seed are 2.80 mm in length, 1.69 nm in width and 0.82 mm in thickness. The geometric mean diameter sphericity,

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surface area and density are 1.56 mm, 7.80 mm^2 and 1224 kgm^{-3}, respectively. The coefficient of friction varies from 0.39 on glass to 0.54 on plywood, while the angle of response is 32.0° (Tunde-Akintunde and Akintunde, 2004). Sesame seed consists of a spermoderm, endosperm and cotyledon. The outer epidermis composes a single layer of cells which contain a mass of calcium oxalate crystals in the outer ends of the cells. The endosperm consists of two to five cell layers with thick rigid walls and is separated from the spermoderm by a membrane. These cells contain oil drops and small aleurone grains. The cotyledon consists of isodiametric cells which contain oil drops and aleurone grains (Figure 1).

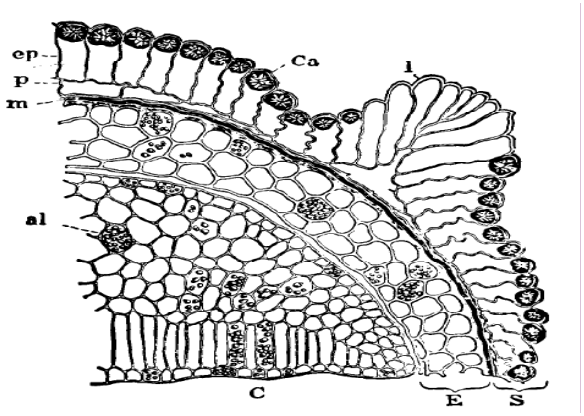

Figure 1. Sesame seed cross-section: Spermoderm (S): (ep; outer epiderm with calcium oxalate crystal masses, m; inner cuticle), Endosperm (E) and Cotyledon (C) (al; aleurone). Source: Carter *et al*. (1961)

Chemical compositions of sesame seeds

The chemical composition of sesame seed from different reports is listed in Table 1 (Badifu and Akpagher, 1996; Egbekun and Ehieze, 1997; Gandhi *et al*., 2007; Nzikou *et al*., 2009). Sesame seed is rich in oil and protein. The seeds contain 4.50-11.00% moisture, 48.20-56.30% fat, 19.10-26.94% protein, 2.00-5.59% ash, 2.50-3.90% fiber and 10.10-17.90% carbohydrate. The composition of the sesame seed is dependent on genetic, environmental factors, variety, cultivation, climate, ripening stage, the harvesting time of the seeds and the analytical method used (Kinman and Stark, 1954; Salunkhe *et al*., 1992).

Extraction of sesame proteins

Apart from being an important oilseed source, sesame seed is a potential source of proteins. In the sesame oil industry, sesame oil is extracted by either using organic solvents or by mechanical pressing. Sesame meal is a by-product after oil extraction. Four types of meals can be obtained from sesame seeds, whole seed meal, dehulled seed meal, defatted whole seed meal, and dehulled-defatted meal. Formally whole sesame seed was crushed to process its oil content. However, the meal could not be used. Sesame seed hulling is now done if the meal is to be used as a food ingredient. Dehulling reduces the oxalic acid content because oxalic acid is associated with the outer epidermal layer and dehulling increases the protein content in the meal because the hull is primarily composed of fiber and dehulling improves enzymatic digestibility (Johnson *et al*., 1979) . Numerous methods have been used to dehull, such as soaking the seed in water, incorporating abrasion of soaked seed and washing the hulls away over screens, peeling by hot dilute alkali solutions (sodium hydroxide, sodium borate or sodium hypochlorite) and sieving or air classification (Johnson *et al*., 1979).

Sesame meal has a composition of 7.92% moisture, 27.83% fat, 30.56% protein, 6.22% fiber, 5.27% ash and 28.14% carbohydrate. Extraction of oil has led to increased protein content of defatted sesame meal (41.15-49.58%) (De Padua, 1983; Onsaard *et al*., 2010). This meal can be used as a protein source ingredient in the food industry.

Sesame proteins have been extracted by various methods, alkaline or salt extraction and isoelectric precipitation (pI) (Dench *et al*., 1981; Rivas *et al*., 1981; Inyang *et al*., 1996; Onsaard *et al*., 2010; Cano-Medina *et al*., 2011). Generally, the positively and negatively charged groups on the protein molecules are equal in number when the pH of the protein is at the isoelectric point. Proteins have minimum solubility at this pH. The method is often called isoelectric precipitation (Li-Chan, 1996). Sesame protein isolate is prepared from defatted sesame flour by alkaline extraction (pH 10 and precipitated at pH 4.0) and salt extraction (1 M NaCl at pH 6 and precipitated at pH 4.0). The two sesame protein isolates contain approximately 95% protein (Rivas *et al*., 1981). The sesame protein concentrate is prepared by defatted sesame flour by dispersing in distilled water at a flour-to-water ratio of 1:6 (wt/vol) and the pH is adjusted with 0.1 M HCl to pH 4.5 to make protein and polysaccharide insoluble. The processing of the sesame flour to sesame protein concentrate resulted in 70.7% protein (Inyang et al., 1996). Onsaard *et al*. (2010) prepared three sesame protein concentrates from defatted sesame flour (DSF) by two different methods; (i) salt solution and isoelectric precipitation (SPC-salt) and (ii) alkali solution pH 9 or pH 11 and isoelectric precipitation at pH 4.5 (SPC-pH 9 and SPC-pH 11). The protein recoveries in SPC-salt, SPC-pH 9 and SPC-pH 11 based on the Kjeldahl procedure were 19.5%, 21.9% and 35.3%, respectively. Protein contents of SPC-pH 9 (82.9%) and 11 (83.3%) was higher than those of SPC-salt (75.5%). This result indicated that differences in preparation process

Table 1. Chemical composition (g/100 g dry weight) of sesame seed

Chemical composition	Badifu and Akpagher (1996)[1]	Egbekun and Ehieze (1997)[2]	Gandhi and Srivastava (2007)[3]	Nzikou *et al*. (2009)[4]
Moisture (%)	4.50	7.00	11.00	5.70
Fat (%)	56.30	48.20	48.21	54.00
Protein (%)	24.60	19.10	26.94	20.00
Ash (%)	2.00	5.20	5.59	3.70
Fiber (%)	2.50	3.60	3.90	3.20
Carbohydrate (by difference)	10.10	17.90	5.59	13.40

Source: [1] Badifu and Akpagher (1996); [2]Egbekun and Ehieze (1997); [3]Gandhi and Srivastava (2007); [4] Nzikou *et al*. (2009)

affect proximate compositions of protein content. SPC contained a high amount of protein, which was slightly higher than that reported by Inyang and Iduh (1996).

Aqueous extraction process (AEP) has been considered as a good option for simultaneous extraction of oil and protein. Since AEP avoids damage to the oil and proteins of the seed and allows production of food-grade instead of feed-grade protein products. It also eliminates chemical refining steps and the oil produced through this process is more suitable for human consumption due to its better nutritive quality (Latif and Anwar, 2009). Latif and Anwar (2011) studied aqueous enzymatic sesame oil and protein extraction. The ground seed was mixed with distilled water at a ratio of 1:6 w/v, boiled for 5 min and cooled down. The pH was adjusted to the optimal point for each enzyme (Protex 7L, Alcalase 2.4L, Viscozyme L, Natuzyme, and Kemzyme). The mixture was incubated at 45°C for 120 min followed by centrifugation, which was given three phases; oil phase, creamy phase and aqueous phase. Alcalase 2.4L was found to be the best for attaining a high oil yield (57.4% of the total oil content in the seed), whereas the maximum amount of protein (87.1% of the total seed protein) was recovered in the aqueous phase with Protex 7L.

Characteristic of sesame proteins

Sesame proteins have been classified in four classes of protein based on Osborne sequential extraction and different solubility; the water soluble albumins, the salt soluble globulins, the prolamins soluble in alcohol/water mixtures and glutelins soluble in dilute acid or alkali. Rivas *et al*. (1981) reported that most of the proteins in sesame flour were 8.6% albumin, 67.3% globulin, 1.4% prolamin and 6.9% glutelin. Furthermore, they reported that alkali protein isolate (extracted in water at pH 10 and precipitated at pH 4.0) comprised of 41.3% albumin, 14.8% globulin, 0.8% prolamin, 41.0% glutelin. Salt protein isolate (extracted in 1 M NaCl at pH 6 and precipitate at pH 4) contained 3.8% albumin, 2.5% globulin, 0.9% prolamin and 35.2% glutelin.

Sesame proteins were shown to contain two major storage proteins; 11S globulin (α-globulin) and 2S albumin (β-globulin). The two protein types were isolated by precipitation with ammonium sulfate. The α-globulin was obtained as crystals in the form of tetragonal bi-pyramids and β-globulin showed as an amorphous white powder. The sesame meal contains 4 times as much α-globulin as β-globulin (Jones and Gersdorff, 1927). The 11S globulin and 2S albumin constitute 80-90% of the total sesame proteins (Tai *et al*., 2001). The major fraction of α-globulin is 70% of the total protein in sesame seed and a 13S globulin represents 95% of the α-globulin. Guerra and Park (1975) reported that the sesame protein separated into seven fractions and the molecular weights of the fractions were 51.0, 31.0, 28.5, 25.5, 21.8, 20.5 and 17.9 kDa. The 13S globulin in sesame seed was composed of acidic and basic subunit. The molecular weights of the acidic and basic subunits were estimated at around 30.5-33.5 kDa and 20.0-24.5 kDa, respectively (Okubo *et al*., 1979). A 7S globulin constitutes approximately 5% of the total sesame protein and is a minor constituent of the total storage proteins in sesame. Comparison of the polypeptide bands of the 7S and 11S globulins by sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) showed that the purified 7S globulin was free of legumin-like contaminant polypeptides and of the 2S albumin. The purified 7S globulin was composed of at least eight polypeptide chains ranging from 12.4 to 65.5 kDa and did not contain disulphide bonds (Orruño *et al*., 2007). The identity of the purified polypeptides was verified by comparing the N-terminal amino acid sequences of the main polypeptide bands with the amino acid sequence deduced from cDNA clone, which encoded the sesame 7S globulin precursor (Orruño *et al*., 2007).

The molecular weight of sesame 2S albumin is in the range of 13-15 kDa linked by a single polypeptide chain (Rajendran and Prakash, 1988; Tai *et al*., 1999;

Table 2. Amino acid composition of sesame flour and sesame protein isolate with required values suggested by FAO/WHO

Amino acid (g./16 g of N)	Sesame flour	Sesame protein isolate			FAO/WHO
	Brito and Nunez (1982)[3]	El-Adawy, (1997)[4]	Johnson *et al* (1979)[1]	Rivas *et al* (1981)[2]	
Cystine	2.2	-	0.8	-	-
Isoleucine	4.1	3.9	3.6	4.0-4.1	4.00
Leucine	7.1	6.7	6.6	6.6-6.7	7.0
Lysine	3.8	2.6	2.1	2.2-2.4	5.5
Methionine	3.7	2.5	2.9	2.1-3.2	-
Phenylalanin	6.0	4.5	4.2	4.6-4.8	-
Tyrosine	5.1	3.7	3.7	3.6-3.9	-
Threonine	4.0	3.4	3.3	3.6-3.7	4.0
Tryptophan	-	-	1.8	-	1.0
Valine	4.7	4.7	4.6	4.9-5.2	5.0
Aspartic acid	7.3	8.2	7.3	7.0-8.0	-
Glutamic acid	14.0	16.2	20.3	13.5-14.5	-
Serine	4.0	4.2	4.2	4.1-4.3	-
Arginine	9.3	12.5	11.7	11.2-11.5	-
Alanine	5.1	3.4	4.3	4.0-4.2	-
Histidine	2.3	2.4	2.1	2.5-2.6	-
Glycine	7.3	4.8	8.9	3.9-4.0	-
Proline	-	7.8	4.6	5.7-5.9	-

Source: [1]Johnson (1979); [2]Rivas *et al.*(1981); [3]Brito and NÚÑEz (1982); [4]El-Adawy (1997)

Hsiao *et al*., 2006). However, it has been reported that the sesame 2S albumin can be cleaved into a subunit of 9 kDa and 4 kDa. Pastorello *et al*. (2001) reported that the major sesame allergen was 2S albumin precursor which was 14 kDa. The molecular weight of sesame proteins has been determined by SDS-PAGE.

The amino acid composition of sesame flour, sesame protein isolate and values suggested by FAO/WHO are shown in Table 2. The sesame flour and sesame protein isolate have been found to be deficient in lysine compared with the FAO/WHO reference protein and rich in glutamic acid and arginine. Isoleucine, leucine, threonine and valine are shown at similar with the FAO/WHO reference values. Sesame flour and protein isolate contain high amounts of total sulfur-contenting amino acids methionine and cystine, 5.9 g/16 g of N and 3.7 g/16 g of N, respectively. Most plant proteins are low in total sulfur-contenting amino acid such as soy protein (1.68 g/16 g of N) (Iwe *et al*., 2001), wheat flour (3.8 g/16 g of N), barley grain (4.0 g/16 g of N), rice milled (3.7 g/16 g of N) (Pete, 2007) and maize corn flour (3.5 g/16 g of N) (Brito and NÚÑEz, 1982), so that sesame is unique in having high total sulfur-contenting amino acid content. Thus, the amino acid composition of sesame protein can be used as a supplementing diet base on cereal and legumes.

Functional properties of sesame proteins

Functional properties have been defined as "those physical and chemical properties that influence the behavior of proteins in food system during processing storage, cooking, and consumption" (Kinsella, 1976). Functional properties of protein are important in food processing, and food formulation. Some of the functional properties are solubility, water and oil holding capacity, foaming capacity and stability, gelation, bulk density and viscosity. Nonetheless, some of these properties are affected by the intrinsic factors of proteins such as molecular structure and size, and environmental factors such as extraction of protein sources. The importance of these properties varies with the type of food products in which the protein isolate is to be used. For example, protein isolates with high oil and water holding capacity are desirable for use in meat products, while protein with high emulsifying and foaming properties are good for salad dressing and soup (Ahmedna *et al*., 1999).

Inyang and Iduh (1996) reported the effect of pH and NaCl concentration on protein solubility, emulsifying and foaming properties of sesame protein concentrate. The least protein solubility (2.2%) occurred at pH 4. At above and below pH 4, solubility increased 6.6% at pH 2 and 13.1% at pH 10. The protein solubility of sesame protein concentration increased with increase in ionic strength, ranging from 9.8%

Table 3. Water and oil holding capacity and bulk density of sesame protein isolate (SPI) and soy protein isolate

Sample	Water holding capacity (g)	Oil holding capacity (g)	bulk density (g mL^{-1})
SPI	1.29 ± 0.66b	302 ± 1.00a	0.169 ± 0.001 a
Soy protein isolate	1.34 ± 2.00a	289 ± 0.58a	0.216 ± 0.001 a

Source: Kanu *et a*l. (2007)

at 0 M. NaCl to 16.1% at 1.0 M NaCl. The emulsion capacity ranged from 6.2 mL oil/g sample at 1.0 M salt concentration. Stability of the emulsion increased with increase NaCl concentration, ranging from 42% at 0 M. concentration to 70% at 1.0 M concentration, but 0.5 M NaCl produced the most stable foam after 120 min of whipping while the least stable was at 1.0 M NaCl. Khalid *et al*. (2003) reported that the minimum nitrogen solubility of sesame protein was 12% at pH 5 and maximum was 90% at pH 3. Emulsifying capacity, emulsifying activity, emulsion stability, foaming capacity and foaming stability were affected with pH levels and salt concentrations. Lower values were showed at acidic pH and high salt concentration. The sesame protein had a water holding capacity of 2.10 ml H_2O/g protein, oil holding capacity of 1.50 ml oil/g and bulk density of 0.71 g/ml. The hydrophilicity/hydrophobicity balance, which depends on the amino acid composition, particularly at the protein surface, influences the protein solubility. Higher solubility is related with the presence of a low number of hydrophobic residues, the elevated charge and the electrostatic repulsion and ionic hydration occurring at pH above and below the isoelectric pH (pI). Denaturation affect protein solubility due to alterations in the hydrophobicity/ hydrophilicity ratio of the surface (Moure *et al*., 2006). Salting-in and salting-out effects, related with the protein surface characteristic, affect protein solubility, which influence thickening, foaming, emulsification and gelation (Damodaran and Paraf, 1997). When comparing emulsifying properties and protein solubility of a sesame protein isolate with those of a soybean protein isolate, it was found the emulsifying activity index (EAI) of the sesame protein isolate were better than those of the soybean protein isolate at pH 4 and 7. For protein solubility, the sesame protein isolate was about 15 times more soluble than the soybean protein isolate at acidic pH 2-4, but not in neutral and alkaline condition (López *et al*., 2003). Kanu *et al*. (2007) reported that a sesame protein isolate produced by varying four parameters (pH, temperature, time and ratio of flour to water as 12, 45^{O}C, 45 min and 6/100 mL^{-1}) had a minimum solubility in the region of between pH 4.5-5, the same as a commercial soy protein (Figure 2). Isoelectric points (pI) of pH 4.4 and pH 4.8 of sesame α-globulin have been recorded (Prakash *et al*., 1978). Protein solubility of sesame protein and soy protein increased at both sides of the pI region. The pH affects charge and electrostatic balance within and between proteins. Below and above the pI, proteins have positive or negative net charges, which enhance their solubility. For most proteins, minimum solubility occurs at their pI region, where electrostatic repulsion and ionic hydration are minimum and hydrophobic interaction between surface nonpolar patches is maximum (Damodaran *et al*., 1997). Interactions of water and oil with protein are important in food systems because of their effects on the flavor and texture of food. Intrinsic factors affecting water binding of food protein include amino acid composition, protein conformation and surface polarity/hydrophobicity (Barbut, 1999). Water holding capacity of a sesame protein isolate was higher than those of soy protein isolate, while the oil holding capacity of a sesame protein isolate was lower than those of a soy protein isolate. Water holding capacity refers to the ability a protein matrix, such as protein particles, protein gels or muscle, have to absorb and retain water against gravity. This water includes bound water, hydrodynamic water, capillary water and physically entrapped water. It improves juiciness in foods (Scheraga *et al*., 1962). Oil absorption is mainly attributed to the physical entrapment of oil and to the number of nonpolar side chains on proteins that bind hydrocarbon chains on the fatty acids. Sesame protein isolates have a less dense mixture than soy protein isolates. Several reports have attributed solubility, hydrodynamic properties, hydrophobicity and microstructure of protein playing an important role in the bulk density of protein isolate (Añón *et al*., 2001; Krause *et al*., 2001), but some reports have attributed to the fact that since protein isolate is rich in protein, it will have a low bulk density as there will be little amount of carbohydrate that increases the bulk density of food products (Krause *et al*., 2002).

Onsaard *et al*. (2010) studied functional properties of sesame protein concentrate. Three sesame protein concentrates were prepared from defatted sesame

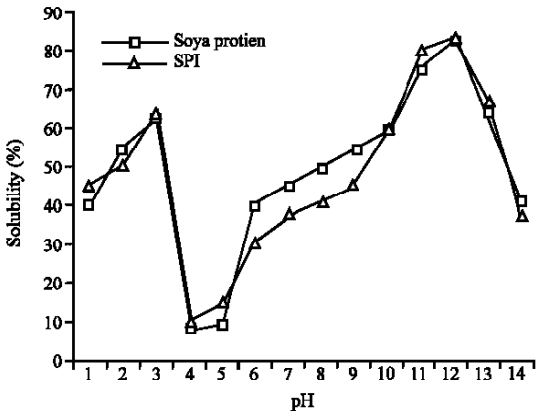

Figure 2. Solubility of sesame protein isolate and commercial soy protein isolate. Source: Kanu *et al*. (2007)

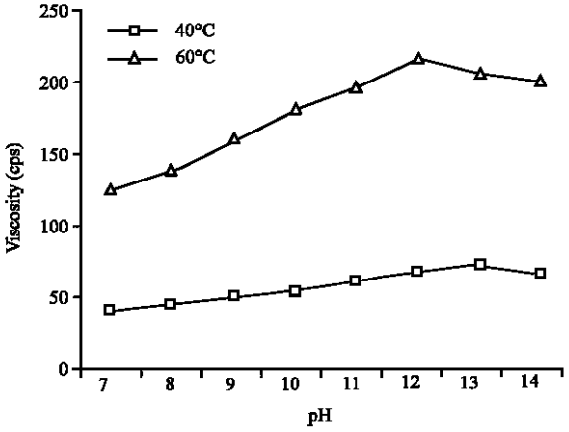

Figure 3. Viscosity of sesame protein isolate at different pH at 40 and 60°C. Source: Kanu *et al*. (2007)

flour by two different methods; (i) salt solution and isoelectric precipitation (SPC-salt) and (ii) alkali solution pH 9 or pH 11 and isoelectric precipitation. The minimum protein solubility of all sesame protein concentrates was found at pH 5. All protein samples were more soluble than soy protein at pH 3, 8 and 9. Emulsion activity index (EAI) of all sesame protein samples was superior to those of soy protein, while emulsion stability index (ESI) of all sesame protein samples was inferior to those of soy protein. Water holding capacity, fat absorption capacity and foaming properties of sesame proteins were lower than those of soy protein. Viscosity of sesame protein isolate at different pH at 40 and 60°C is shown in Figure 3. The viscosity of sesame protein isolate at 60°C was higher than those of at 40°C, because the high temperature helped the denaturation of protein that increases the viscosity. The low viscosity of sesame protein isolate may be useful in the development of high protein drink, juice-based beverages and its supplementation in infant formulation without (Kanu *et al*., 2007).

Modification of sesame proteins

Most native proteins do not display functional properties desirable for food industries. Modification of protein can be used to improve the functional properties, especially protein solubility. Modification implies changes in both protein structure and conformation at different levels; and optimal characteristics of size, surface, charge, hydrophobicity/hydrophilicity ratio and molecular flexibility of protein can be achieved (Feeney and Whitaker, 1985).

A protein is usually modified by chemical and enzymatic treatment, causing change in its conformation, structure, physicochemical and functional properties (Chobert *et al*., 1988). Most of chemical modifications were aimed at changing the net charges on the protein by substituting the Ɛ-amino groups, which influenced the solubility of the protein (Panyam and Kilara, 1996). However, many of the modifications are unsuitable for food use because of the high costs, toxicity, deterioration of organoleptic properties, nutritional value loss, interaction with other foods, reversibility of modification, as well as difficulty in reaction control (Howell, 1996; Panyam and Kilara, 1996).

Enzymatic modification is favored because of the milder process condition, occurring at moderate temperature and atmospheric pressure and it has an advantage of potential stereochemical specificity (Hall, 1996). Proteolytic enzymes are classified according to their source of origin (animal, plant and microbial), the nature of the catalytic site and their catalytic action (endopeptidase and exopeptidase). Endopeptidase act by hydrolyzing bonds within the polypeptide chains between specific amino acids, which results in smaller peptide chains. Exopeptidases cleave single amino acids or dipeptides only from terminals; N-terminal (aminopeptidases) and C-terminal (carboxypeptidase) (Adler-Nissen, 1993). Proteolytic enzyme modification of protein is an effective way to improve the various functional properties and to increase the field of application of the protein (Panyam and Kilara, 1996). The peptides that are produced by partial hydrolysis of proteins have smaller molecular size and less secondary structure than native proteins. The protein solubility, emulsifying properties and foaming capacity can be improved with limited degree of hydrolysis (Kim *et al*.,1990), whereas excessive hydrolysis causes loss of some of these functionality (Kuehler and Stine, 1974).

Only a few studies have been done to prepare sesame protein hydrolysate and to evaluate the functional properties of sesame protein

(Bandyopadhyay and Ghosh, 2002) and to evaluate the antibacterial activity on typical pathogens (Das *et al*., 2012). Bandyopadhyay and Ghosh (2002) produced papain-modified sesame protein isolate from dehulled, defatted sesame meal, and used as a starting material. Protein solubility of papain-modified sesame protein isolate increased from 55.97% for control to 88.82-93.36% for hydrolysate with 0.1 % w/w papain for 10-60 min. The increased protein solubility could be due to smaller molecular peptides being produced by papain hydrolysis. Papain modification improved the emulsion activity index (EAI) of sesame protein isolates from 114.33 m^2/g to 179.52-208.83 m^2/g for hydrolysate for 10-60 min. The EAI is mainly dependent on the diffusion of peptide at oil-water interfaces. The hydrolysates with higher solubilities and small molecular size should facilitate that diffusion and enhance the interaction between proteins and lipids. The protein hydrolysates exhibited larger foam capacity, ranging from 111.3 to 136.9% volume increase, than the control (61.9%). Protein hydrolysates are wildly used as nutrition supplements, functional ingredients, and flavor enhancers in foods, coffee whiteners, cosmetics personal care products, confectionary, fortification of soft drinks, juices, soups, sauces, meat products and other savory application (Weir, 1986). Das *et al*. (2012) prepared sesame protein hydrolysate and evaluated the antibacterial activity. The sesame protein hydrolysates were produced using enzyme membrane reactor, Metallo-endopeptidase "Protease A Amano 2G" (Aspergillus oryzae) (E.C.3.4.24.39, activity 20,000 U/g), followed by successive fraction using ultrafiltration membranes of decreasing molecular weight cut off (5, 2, 1 kDa) to obtain fractions of sesame protein hydrolysate. The antibacterial activity of sesame peptides on two pathogens (*Pseudomonas aeruginosa* and *Bacillus subtilis*) was evaluated. Sesame peptides are more active in inhibiting the growth of gram negative bacterium (*P. aeruginosa*) than for gram positive bacterium (*B. subtilis*). Hence, it is reasonable to speculate that sesame peptide has bacteriostatic effect and can be incorporated in the therapeutic formulation as bacteriostat. Peptides with low molecular weight (<1 kDa) were more effective compared to the complex protein molecules and crude protein hydrolysate. The probable mechanism for bacteriostatic action of methionine rich peptides is related to DNA synthesis (Fauci *et al*., 2008).

Conclusion

This article has mainly focused in the understanding of the sesame proteins. Improved knowledge of these proteins can use to apply a new protein source obtained from an alternative crop to soybean. The information of characteristics and functional properties of the sesame protein allow its use in food ingredients and in food formulation systems such as meat and sauce products.

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