



Short Communication

Preparation of soy protein concentrates by different treatment processes

Shumaila Usman, Ammara Yasmeen, Saima Nazir, Shaista J. Khan, Sakhawat Ali and Imran Kalim*

Food and Biotechnology Research Centre, PCSIR Laboratories Complex, Ferozpur Road Lahore, Pakistan
ikalim@hotmail.com

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Abstract

This study aimed to develop soy protein concentrate (SPC) from soybean. SPC was produced using different concentration of acetic and citric acid (40, 50 and 60%), purpose of developing the concentrate and residue was to get value add products rich in protein and fiber. The experimental work was also carried out to determine the chemical compositions of whole soybean seed, defatted soybean, SPC and soy protein residue (SPR) by proximate analysis i.e. moisture, ash, fat, fiber and protein contents. Citric acid and acetic acid being edible acids were used to get highest protein content of soy protein concentrate and to see the maximum yield as well. High protein content of 87.49% was obtained from SPC with 60% citric acid concentration and high fiber content of 13.36% was obtained from SPR with 50% citric acid concentration. While in case of acetic acid, high protein content of 69.81%, and high fiber content of 10.50% were obtained with 60% and 40% acetic acid. The protein content obtained from SPC was significantly higher than from SPR. Unlike the protein content, high fiber was found only in SPR in both the acids used.

Keywords: Soy protein concentrate, Citric acid, Isolation treatments, Composition analysis.

Introduction

Soy bean (*Glycine max*) is a leguminous plant¹. Soybeans can be eaten whole or they can be turned into different food products. Soy is high in protein and sometimes this protein can be extracted from the rest of the plant, where it can be used as a food additive or made into meat replacements. Protein bodies are particles in most of the storage proteins as in soya bean protein, 60–70% of the total storage proteins are of soy protein².

Among most important vegetable source of protein Soybean is also used as essential ingredients for food formulation. Flour, Soy protein concentrate and isolate are three major soy protein products. Soy proteins concentrate containing a minimum of 65% protein is a refined, balanced protein product.

Defatted soybean fragments or its flour is used to develop Soy protein Concentrate after removing non protein nitrogen contents. Various methods has been developed which are generally used for preparing soy protein concentrates: the aqueous alcohol wash process, the acidic wash process and the heat denaturation/water wash process³.

Another most important nutritional component of Soybean is dietary fiber containing both soluble and insoluble fiber. Dietary fiber helps to protect against cardiovascular diseases such as diabetes by controlling blood sugar, obesity, colon cancer and other diverticular diseases⁴. Among dietary proteins soy proteins contains all the essential amino acid so is categorized as a whole protein source as it must be provided to human-body⁵.

Edible soy proteins may be in the form of flours, concentrates, or isolates which is developed from fat free soybean flakes. Soy protein concentrates is produced following the process of extracting the proteins in aqueous alcohol or with a dilute acidic solution in the pH range of 4.0 to 4.8. Soy proteins isolates are produced by extracting the soy flour with a dilute alkali (pH < 9) followed by centrifugation contain a minimum of 90% protein on a dry weight basis³. Sulfuric, hydrochloric, phosphoric, or acetic acid is used to adjusted pH to 4.5 as to enable precipitation of proteins. Centrifugation process of acid-precipitated protein is carried out following the washing, neutralization, and spray-drying to produce the soy protein isolate⁶. The yields of soy isolates and concentrates vary between 60 to 70% of the protein in the flour³.

Classification of soy proteins can be made into different categories according to the method of their development. Soy protein concentrate is relatively more textured and protein contents increases upto 70% in it⁷.

Soy protein is extracted from plant origin making it more essential than all other plant extracted proteins having highest contents isoflavones⁸. The analytical method for evaluation of quality of protein that is universally recognized by the Food and Agriculture Organization and World Health Organization (1990) along with the Food Development Authority, United Nations University (UNU) and the National Academy of Sciences is, Protein Digestibility Corrected Amino Acid Score (PSCAAS). This method evaluates the accurate comparative nutritional value of animal and vegetable originated protein in the food

material. According to this method of analysis extracted soy protein is measured to have protein quality comparable to animal source protein. As egg white has a score of 1.00, beef 0.9 and concentrated soy protein 0.92⁹.

Apart from contributing to nutritional benefits production of soybean has been an important area for workers. Through extensive studies soybean is gifted to have miraculous attributes such as lowering of blood cholesterol, blood sugar and prevention of certain cancer. Digestibility of soy protein is higher Soy protein is highly digestible (92% to 100%) and it comprises all essential amino acids. Extracted soy protein is low in methionine, but it has more lysine contents as well¹⁰. Consumption of soy concentrate helps in reduction of risk of colon cancer, possibly due to its sphingolipids contents¹¹. Omega3 fatty acids present in soybean oil also have been shown to be anti-carcinogenic¹².

According to the evaluation conducted by the Food and Drug Administration, consumption of 25 grams of soy protein per day, as source of lowering saturated fat and cholesterol in diet help in reduction of risk of heart disease¹³. Soya bean have a very low glycemic index and can be valuable if added to a diabetic diet¹⁴. The protein requirement of a person with diabetes increases and this can be met with ease by adding soya bean and soya products to the diabetic diets¹⁵. The greater part of the residue in soybean meal is used in the manufacture of animal feed. Soybean extracts used in in a large variety of processed foods¹⁵.

Soy protein concentrate is essentially partially purified protein from soy. Soy protein concentrate is made from whole soybeans which have had their hulls removed and have had the soybean oil and other fats taken out of the product. Studies on determining the role of soy protein in human nutrition is important in view of its increasing use in diets of populations in technically advance nations. Previous short term nitrogen balance studies have shown that, when consumed in sufficient quantities, soy proteins may also use as the role source of available nitrogen and all amino acids needed by the body for all young, children and adults¹⁶.

The aim of current study was to extract soy protein concentrate (SPC) from defatted soybeans using different concentration of acetic acid, and citric acid (edible acids). Previous studies (words deleted) carried out with a mineral acid HCl. Although, the soybean food and forage products developed form HCl are being used worldwide yet edible acids such as acetic acid and citric acid could be better choice for extracting soy protein concentrate for ultimate development of products. The chemical composition of the available soybean variety was determined for comparison with the previously reported values obtained with HCl.

Methodology

Preparation of Soy Protein Concentrate: 100 grams of defatted soybean flour was weighed and 500 ml of 0.03 N

NaOH (1.20 gram in 1000 ml of distilled water) was added and pH was maintained at 7. This sample was placed on the shaker at 5°C for four hours. After 4 hours sample was centrifuged at 15000 rpm for 15 minutes. As a result of centrifuge two layers were obtained. Upper layer of the low density layer also called supernatant was separated and 40 ml of 40% citric acid was added in it. Coagulation occurred due to the presence of protein in the supernatant. pH was maintained at 4.5-5.6 (Isoelectric point for protein coagulation). While the lower layer of high density serves as the residue. The supernatant with added citric acid was again centrifuged at 15000 rpm for 15 minutes and two layers were formed.

The upper taken in a silk cloth and was washed with mild warm water and was neutralized at pH 7. It was placed for spray drying for overnight. Next day the dried concentrate and residue were weighed separately and were placed in packets for future use. This was 40% soy protein concentrate (40% SPC) extracted from defatted soybean using 40% citric acid. Similar procedure was followed to prepare 40% SPC using acetic acid. For preparing 50% and 60% SPC from citric acid and acetic acid, same procedure will be followed except for the difference in acid concentrations i.e. 50% citric acid, acetic acid, and 60% citric acid and acetic acid were used to prepare 50% and 60% soy protein concentrates respectively.

Compositional analysis: The compositional analysis of soy Soybeans, de-fatted soybeans, soy protein concentrate and residue, included moisture, ash, fiber and protein content¹⁷.

Statistical analysis: All treatments were in duplicate and analyses were done in triplicate. Data was analyzed using a one factor analysis of variance (ANOVA) and least significant differences (LSDs) were calculated at the 5% level to compare group means using the Statistical Product and Service Solutions software package (SPSS, version 19.0).

Results and discussion

Statistical method has mentioned in material and methods. Statistical evaluation of values obtained represent that by use of hexane observed higher extraction rate (1.4% residual fat), followed by the ethanol (3.8%) and methanol (14.5%). Differences in defatting efficiencies of the solvents depend upon the polarities of solvents used. Thus methanol observed to be less efficient in less polar lipids relative to ethanol and hexane.

The nutritional evaluation of whole soybean seed, defatted soybean, soy protein concentrate (SPC) and soy protein residue (SPR) showed interesting results of moisture, ash, fiber, and protein contents. These values may vary to some extent depending on the type or variety of the soybean chosen. Comparing these values with the values of defatted soybean, it was observed that the moisture, ash and protein values are higher in defatted soybean than in whole soybean seed, except for the fiber which is of higher value in whole soybean seed as

shown in the Table-1. It is because of the fact that with removal of fat, moisture content increases and fiber content decreases in the defatted soybean.

Table-1: Proximate composition of soybean seed and defatted seed.

Parameters	Soy bean seed	Defatted soy bean seed
Moisture (%)	5.52±0.05	8.52±0.27
Ash (%)	5.00±0.01	5.92±0.12
Fat (%)	17.5±0.02	0.00
Protein (%)	39.9±0.07	49.95±1.90
Fiber (%)	7.4±0.04	4.92±0.18

The proximate analysis of soy protein residue (SPR) and its concentrate obtained using different concentrations (40%, 50%, and 60%) of citric acid & acetic acid are given in Table-2.

Table-2: Proximate compositions of soy protein concentrate treated with different concentration of citric acid and acetic acid.

Parameters	Soy bean seed	Defatted soy bean seed
Moisture (%)	5.52±0.05	8.52±0.27
Ash (%)	5.00±0.01	5.92±0.12
Fat (%)	17.5±0.02	0.00
Protein (%)	39.9±0.07	49.95±1.90
Fiber (%)	7.4±0.04	4.92±0.18

Comparing moisture and ash values of soy protein concentrate (SPC) and soy protein residue (SPR), more moisture content is found in SPR than SPC with 60% citric acid while ash content with highest value is observed in SPR with 50% citric acid. Result indicated that ash is rich in minerals because all of the organic part is burnt at higher temperatures of 550°C the muffle furnace (Table-2, 3).

The present study emphasizes on the isolation of soy protein concentrate (SPC) from defatted soybean using 40%, 50%, and 60% citric acid and acetic acid concentration. Defatted Soya bean preliminary for the development of soy protein concentrate for getting maximum protein content in concentrate. Protein must first be concentrated from its combined complex forms (particularly lipoproteins and other complex compounds of protein) present in the soybean seed. It is due to the fact that in combined state with lipids, hindrance occurs in precipitation of proteins for the development of soy protein concentrate (SPC) therefore, percentage of fat was found only in soybean seed because the other entire soybean was defatted for the preparation of soy protein concentrate. For this purpose hexane was selected as a solvent to achieve maximum extraction.

Acetic acid and citric acid, both edible acids were used for the preparation of soy protein concentrate (SPC). With the enhancing the concentrations of acetic acid, and citric acid the protein content increased. Maximum protein content was obtained with highest concentration of 60%. These results show that being weak acids, they need higher concentration for precipitating proteins. Citric and acetic acids are classified by the Food and Drugs Administration (FDA) as GRAS (Generally Recognized as Safe) for miscellaneous and general usage in foods. It is often used to create a repaid build up or "Burst" in the taste¹⁸.

It is also found that soybean has more than two times the amount of most of the minerals especially calcium, iron, phosphorous and zinc than any other legume and very low sodium content¹⁹. This show that SPC has minimum ash content and it could be beneficial if clinicians recommend low mineral diet to their renal patients²⁰.

Table-3: Proximate compositions of soy protein residue treated with different concentration of citric acid and acetic acid.

Parameters	Citric Acid			Acetic Acid		
	40%	50%	60%	40%	50%	60%
Moisture (%)	5.15±0.04	5.67±0.03	7.38±0.03	7.71±0.01	7.20±0.01	8.24±0.009
Ash (%)	1.41±0.05	2.84±0.01	3.94±0.02	1.26±0.008	2.10±0.03	2.12±0.02
Protein (%)	66.91±0.01	70.82±0.01	87.49±0.01	55.63±0.08	60.93±0.07	69.82±0.14
Fiber (%)	N.D	N.D	N.D	N.D	N.D	N.D

It is found to be beneficial because residue has high fiber content and in the presence of high moisture in residue, swelling capacity of the fiber increases which is easily digested and absorbed by the people and curable for them who are suffering from prolonged constipation. Soy fiber when use in baked goods to promoting softer crumb, improving freshness and enhancing shelf life holds up to three times its weight in water. It could also be beneficial if added to animal feed²¹. The moisture, ash, fiber, fat and protein values of soybean seed obtained in this study were found to be same as reported by²².

Protein content is higher in SPC than in SPR. Maximum protein value of SPC is observed with 60% citric acid concentration. This value is contrary to the value obtained in standard HCl method in which maximum protein value is obtained with 40% HCl. It is due the fact that citric acid is mild or weak acid; therefore higher concentration of this acid is required to get maximum protein content²³. While in case of HCl, due to its strong nature, maximum protein value is obtained at lower concentration i.e. 40% HCl. We come to a conclusion that when protein value is getting higher in SPC with increase in concentration as observed²⁴. Unlike fiber, more protein is present in concentrate than in residue.

Fiber is found to be higher in SPR with 50% citric acid concentration as shown in Table-3. These results indicate that citric acid doesn't have much effect on fiber of SPR. On the other hand, moisture content of SPR increases with increase in the concentration of citric acid.

Conclusion

Soy is high in protein. It contains about 70% protein. Soy protein concentrate (SPO) was produced from soybean using different concentration of acetic and citric acid (40, 50 and 60%). The experimental work was also carried out to determine the chemical composition of whole soybean seed, defatted soybean, SPC and soy protein residue SPR. High protein content of 87.49% was obtained from SPC with 60% citric acid concentration and high fiber content of 13.36% was obtained from SPR with 50% citric acid concentration. While in case of acetic acid high protein content of 69.81% and fiber content of 10.50% were obtained with 60% and 40% acetic acid.

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