

AN IMPROVED PROCESS FOR THE PREPARATION OF SOY PROTEIN CONCENTRATE WITH IMPROVED FUNCTIONAL PROPERTIES

Technical Field

5 The present invention particularly relates to an improved process for the preparation of soy protein concentrate from defatted soy flakes with improved functional properties.

Background Art

Vegetable proteins have formed part of man's diet in developed countries, it is the vegetable sources provide the essential nutrients. Vegetable proteins contribute significant
0 percentage of daily requirement of protein. The richest sources are oilseeds, legumes and cereals. Soybeans are generally acknowledged as high quality vegetable protein source and are the most abundant. Annual production of soy in India is around 6.8 MT. Soy bean has high levels of important nutrients. It contains about 20% oil and 40% protein with very good proportions of essential amino acids. The remaining 40% is carbohydrates which is
15 indigestible and functions as roughage or dietary fiber. Soybean is also good source of vitamins and minerals. The nutritional value of the soy bean is not only factor enhancing its consumption but it also plays an important role in health in preventing heart disease, obesity, blood cholesterol, cancer, diabetes, kidney disease and osteoporosis.

Soy products commonly available for use in food formulations, are soy beans, soy
20 flour(full fat or defatted), soy protein concentrates and isolates. Many soy protein preparations are characterized by undesirable beany and bitter flavour which limiting their use in a variety of food products. In addition to undesirable flavour, it also contains flatus producing indigestible carbohydrates; stachyose and raffinose. The raw soy bean also contains some of the antinutritional factors such as trypsin inhibitors, urease and
25 lipoxxygenase activity.

Soy proteins concentrates are available in granular form, ground flour, textured pieces of various sizes and in spray dried form. Soy proteins concentrate find application in a variety of foods especially as a functional ingredient in bakery and as extenders in meat Industries. Also found use in major non-meat preparations like non-dairy products, health foods and
30 pasta products.

Reference may be made to US patent 3635726, Sair L., 1972, The Griffith Laboratories Inc. Chicago, IL, USA, wherein a method for producing soy protein concentrate by extracting soy bean material with a liquid at pH above the isoelectric pH of glycinin and separation of the liquid to separate the residue is described. The protein in the liquid is

precipitated at isoelectric pH to recover the protein, mixing in a desired proportion to produce soy proteins concentrate. The draw back of the process is that there are too many steps of extraction of proteins combining the protein with fibrous residue to obtain the concentrate.

- 5 Reference may be made to US patent 3965086, Swain, et al., 1976, The Procter & Gamble company, wherein a method for producing soy protein concentrate by grinding and air classification of the oil seed meal and washing the coarse fraction in water at pH 4 – 6 or in 20-80 % aqueous alcohol solutions and drying is described. The draw back of the process is air classification to obtain coarse fraction and washing in acidic water or alcohol. The process has
10 many steps in the processing.

Reference may be made to US patent 3897574, Pass, D.W. 1975, Central Soya Company Inc., wherein soy protein concentrate by prepared units of defatted soy flours by containing with 60-80% ethanol to remove soluble solids. The draw back of the process, the residual solvent in the protein concentrate.

- 15 Reference may be made to US patent 3971856, Daftary, R. D, 1976, Archer Daniel Midland Company, wherein full fat soy protein concentrate is prepared using dehulled soy beans subjected to water at 180-212°F and washing and drying to a moisture level 8-15%. The draw back of the process is rancidity development during storage.

- Reference may be made to US patent 3970764, Karnofsky, G. B., 1976, Dravo Corporation, Pittsburgh, PA, wherein defatted soybean flakes were extracted with aqueous
20 alcohols are used. The draw back of the process is residual solvent in the product.

Reference may be made to US patent 4219470, Karnofsky, G. B., 1980, Dravo Corporation, Pittsburgh, PA, wherein the process includes treating the defatted soybean flakes using alcohol to produce protein concentrate. The draw back of the process is residual solvent in the product

- 25 Reference may be made to US patent 4265925, Campbell, M. F. et al., 1981, A. E. Staley Manufacturing Company, Decatur, IL., USA, wherein the process includes extracting the defatted vegetable protein flakes with an aqueous alcohol solution to remove soluble carbohydrates. The drawback of the process is the residual solvent retained is more than 1000ppm.

- 30 Reference may be made to US patent 4410554, Sailer, D. E., 1983, Central Soya Company Inc., Where in the soy protein concentrate is prepared using aqueous acid leaching in the pH range of 4.4 – 4.6 and separation of solids, neutralization using alkali to a pH range of 6.5-7.5. The slurry is pasteurized and dried. The draw back of the process requires acid alkali to neutralize. A costly spray drying method used for drying.

Reference may be made to US patent 5097017, Konwinski, A. H, 1992, Central Soya Company Inc., where in protein concentrate is prepared using dusty defatted soy flakes or flour after agglomerated by the addition of 18-30% moisture and maintaining the temperature of 160-300 ° F and extracted with 55-75% aqueous ethanol. The drawback of the process is use of high temperature and agglomerating, the material for extraction which is an additional process step.

Reference may be made to US patent 5936069, Johnson, L. A., 1999, Iowa State University Research Foundation, Wherein soy protein concentrate is prepared from soy beans which have been genetically modified to reduce or eliminate the raffinose, stachyose, lipoxxygenase content and associated off flavours. The protein is solubilised using alkali and dried the slurry to get a protein content of not less than 60% on dry basis. The drawback of the process is, genetically modified soy seeds are used and protein content of concentrate is low.

Reference may be made to US patent 6313273, Thomas, R. L. N. et al., 2001, Abbott Laboratories, wherein soy protein concentrate is produced by a process enzyme treatment combined with ultrafiltration.

Object of the Invention

The main object of the present invention is to provide an improved process for the preparation of soy protein concentrate with improved functional properties.

Another object of the present invention is to provide a protein concentrate to eliminate or to reduce lipoxxygenase, urease and trypsin inhibitor activity.

Yet another object of the present invention is to obtain soy concentrate with reduced raffinose and stachyose with a protein content of 70%.

Summary of the Invention

The invention particularly relates to the preparation of soy protein concentrate from defatted soy flakes with improved functional properties. The preparation involves the process of autoclaving, leaching, and drying of defatted soy flakes.

Detailed description of the Invention

The present invention provides a process for the preparation of soy protein concentrate from defatted soy flakes with an improved functional properties, the said process comprising steps of:

- a) autoclaving defatted soy flakes at a temperature range of 100°-110° C for a period of 10-15 minutes,

- b) leaching by percolating water through autoclaved defatted soy flakes of step (a) in two stages,
- c) draining excess water from soy flakes of step (b),
- d) drying the wet flakes of step (c) in a cross flow drier, and
- 5 e) pulverizing and sieving the dried soy flakes of step (d) to get required soy protein concentrate

In an embodiment, provides a starting material as defatted soy flakes having fat content of around 1%.

10 In another embodiment, the drying is effective in a fluidized bed dryer having inlet temperature 80-85°C and outlet temperature 35- 40°C for a period of 25 to 30min.

In yet another embodiment, the protein concentrate may have a protein content of 70-72%.

In an embodiment, the protein concentrate obtained has a particle size of 220 μ -225 μ .

15 In yet another embodiment, the complete inactivation of lipxygenase, and reduction of the urease activity may be 0.2 to 0.5 units and trypsin inhibitor activity may be 6-8 TIU /mg material may be achieved.

In yet another embodiment, raffinose and stachyose contents may be reduced to less than 10% of the original.

In yet another embodiment, product may have a water absorption capacity of 270 ± 1 g/100g and a fat absorption capacity of 122 ± 8 g/100g.

20 In yet another embodiment, the hexanal content may be reduced from 64 μ mole/g to 22 μ mole/g of the original.

In yet another embodiment, the protein concentrate may have 50% reduction in bean flavour of the original by sensory evaluation.

25 In yet another embodiment, the protein concentrate may retain all the amino acid content present in the starting material.

In yet another embodiment, the protein concentrate may have improved protein digestibility (88%) compared to starting material (80%).

In yet another embodiment, the protein concentrate will have good shelf life of 180 days.

30 One more embodiment of the invention provides a soy protein concentrate obtained from defatted soy flakes having the following improved functional properties:

- a) soy protein concentrate has protein content in the range of 70-72%.
- b) the soy protein concentrate has reduced urease activity of 0.2-0.5 units.
- c) the soy protein concentrate has trypsin inhibitory activity in the range of 6-8 TIU/mg.

- d) the soy protein concentrate has raffinose and stachyose contents reduced to 10% of the original content.
- e) water absorption capacity is 270 ± 8 gms/100gm and fat absorption capacity is 122 ± 8 gm/100 gm.
- 5 f) particle size is in the range of 220μ - 225μ .
- g) hexanal content is reduced from to 22μ mole/gm from 64μ mole/gm.
- h) the beany flavor of the soy protein concentrate is by 50%.
- i) the product has all the amino acid contents retained as present in the starting defatted soy flakes.
- 0 j) the product has improved protein digestibility up to 88% .
- k) the product has a shelf life of 180 days.

Novelty of the process:

- I. The novelty of an improved process for the preparation of soy protein concentrate with improved functional properties are:
- 5 II. The use of optimum conditions like temperature, moisture and pressure to maximize destruction of trypsin inhibitor activities, minimize the reduction of solubility and loss of essential amino acids.
- III. The defatted soy flakes are moist heat treated to denature protein and render them insoluble in water.
- 20 IV. Soluble carbohydrates and salts are removed from insoluble protein and polysaccharide material by water leaching and dried to yield concentrate with protein content of 69-72%.
- V. The raffinose and stachyose content is reduced to less than 5-10% of its original value.
- 25 VI. The protein concentrate has improved digestibility of proteins of 88%.
- VII. The process reduces the beany flavour by 50% of the original material.
- VIII. The hexanal content is reduced by 60% of its original.
- IX. The process improved the water and fat absorption capacities.

The main advantages of the invention are:

- 30 1. The protein content of the protein concentrate ranges from 69-72%.
- 2. The yield of protein concentrate ranged from 70-75%.
- 3. The process reduces or eliminates the Lipoxygenase, urease and trypsin inhibitor activities in the product.

4. The process minimizes the flatus producing oligosaccharides, raffinose and stachyose by 96 and 90% respectively.
5. The process improves the *invitro* digestibility of protein to 88%.
6. The beany flavour present in the starting material is reduced by 50%.
- 5 7. The process improves the functional properties such as water and fat absorption capacities.
8. The process preserves all the essential amino acids present in the original material

The following examples are given by way of illustration of the present invention and therefore should not be constricted to limit the scope of the present invention.

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Example 1

Five hundred grams of defatted soy flakes were spread over stainless steel trays and autoclaved at a temperature of 110°C for 15 min. The flakes were soaked in water in a ratio of 1:4 (w/v) in percolating columns for 2h and removed. The process is repeated in a ratio of 1:3 (w/v). The wet flakes were dried at 60°C in a cross flow drier. The moisture and protein content of the soy protein concentrate obtained was 3.4 and 66.6% respectively
15 with an yield of 75%.

Example 2

One kg defatted soy flakes were spread over stainless steel trays and autoclaved at a temperature of 110°C for 15 min. The flakes were soaked in water in a ratio of 1:4 (w/v) in
20 percolating columns for 2h and removed. Repeated the extraction in a ratio of 1:3 (w/v). The wet flakes were dried at 60°C in a through flow drier. The moisture and protein content of the protein concentrate obtained was 4 and 67.7% respectively with an yield of 72%.

Example 3

25 Two hundred grams of defatted soy flakes were spread over stainless steel trays and autoclaved at a temperature of 110°C for 15 min. The flakes were soaked in water in a ratio of 1:4 (w/v) for 2h and removed. The extraction is repeated in a ratio of 1:3 (w/v). The wet flakes were dried at 85°C in a cross flow drier. The moisture and protein content of the soy protein concentrate obtained is 6 and 68.8% respectively with a yield of 70%.

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Example 4

Two hundred grams of defatted soy flakes were spread over stainless steel trays and autoclaved at a temperature of 110°C for 15 min. The flakes were soaked in water in a ratio of 1:4 (w/v) for 2h and drained. The extraction is repeated in a ratio of 1:3 (w/v). The wet flakes were dried at 90°C in a cross flow drier. The moisture and protein content of the

protein concentrate obtained is 6 and 65.3% respectively with a yield of 73%. The product is evaluated for hexanal content; hexanal content reduced from 63.5 μ mole/g to 29 μ mole/g of the original material, and the beany flavour was reduced by 50%.

Example 5

- 5 Five hundred grams of defatted soy flakes were spread over stainless steel trays and autoclaved at a temperature of 110°C for 15 min. The flakes were soaked in water in a ratio of 1:4 (w/v) for 2h and drained. The process is repeated with a ratio of 1:3 (w/v). The wet flakes were dried at 90°C in a cabinet drier. The moisture and protein content of the protein concentrate obtained is 6.3 and 65.9% respectively with a yield of 76%.
0 The product is evaluated for hexanal content reduced from 64 μ mole/g to 22 μ mole/g of the original material, and the beany flavour reduced by 55%.

Example 6

- 4.5 kgs of defatted soy flakes were spread over stainless steel trays and autoclaved at a temperature of 110°C for 15 min. The flakes were soaked in water in a ratio of 1:4 (w/v)
5 for 2h and drained. The extraction is repeated in a ratio of 1:3 (w/v). The wet flakes were dried using fluid bed drier (inlet temp. 85°C and outlet temp 40 °C) for 25-30min. The moisture and protein content of the protein concentrate obtained is 6.2% and 68.5% respectively with a yield of 75%.

Claims

- 1) A process for the preparation of soy protein concentrate from defatted soy flakes with an improved functional properties, the said process comprising steps of:
 - a) autoclaving defatted soy flakes at a temperature range of 100°-110° C for a period of 10-15 minutes,
 - b) leaching by percolating water through autoclaved defatted soy flakes of step (a) in two stages,
 - c) draining excess water from soy flakes of step (b),
 - d) drying the wet flakes of step (c) in a cross flow dries, and
 - e) pulverizing and sieving the dried soy flakes of step (d) to get required soy protein concentrate.
2. A process as claimed in claim 1, wherein in step (a) the fat content of defatted soy flakes is about 1%.
3. A process as claimed in claim 1, wherein in step (b) the ratio of water used in two stages is in the range of 1:4 (w/v) and 1:3 (w/v) respectively,
4. A process as claimed in claim 1, wherein in step (b) the leaching with water is carried out for 1 to 2 hours each time.
5. A process as claimed in claim 1 wherein step (d) the drying is carried out in a cross flow drier for 2 to 3 hours, maintained at a inlet temperature in the range of 85°-95° C and outlet temperature in the range of 35°-40° C.
6. A process as claimed in claim 1, wherein the soy protein concentrate has protein content in the range of 70-72%.
7. A process as claimed in claim 1, wherein the soy protein concentrate has reduced urease activity of 0.2-0.5 units.
8. A process as claimed in claim 1, wherein the soy protein concentrate has trypsin inhibitory activity in the range of 6-8 TIU/mg.
9. A process as claimed in claim 1, wherein the soy protein concentrate has raffinose and stachyose contents reduced to 10% of the original content.
10. A process as claimed in claim 1, wherein the soy protein concentrate has a water absorption capacity of 270 ± 8 gms/100gm and fat absorption capacity of 122 ± 8 gm/100 gm.
11. A process as claimed in claim 1, wherein the soy protein concentrate has a particle size of 220 μ -225 μ .

12. A process as claimed in claim 1, wherein the soy protein concentrate has a hexanal content reduced from 64 μ mole/gm to 22 μ mole/gm.
13. A process as claimed in claim 1, wherein the beany flavor of the soy protein concentrate is reduced by 50%.
- 5 14. A process as claimed in claim 1, wherein the soy protein concentrate has all the amino acid contents retained as present in the starting defatted soy flakes.
15. A process as claimed in claim 1, wherein the soy protein concentrate has improved protein digestibility up to 88%.
16. A process as claimed in claim 1, wherein the soy protein concentrate has improved functional properties.
- 10 17. A process as claimed in claim 1, wherein shelf life of the soy protein concentrate is about 180 days.
18. A soy protein concentrate obtained from defatted soy flakes is having the following improved functional properties:
 - 15 a) soy protein concentrate has protein content in the range of 70-72%.
 - b) the soy protein concentrate has reduced urease activity of 0.2-0.5 units.
 - c) the soy protein concentrate has trypsin inhibitory activity in the range of 6-8 TIU/mg.
 - d) the soy protein concentrate has raffinose and stachyose contents reduced to 10% of the original content.
 - 20 e) water absorption capacity is 270 ± 8 gms/100gm and fat absorption capacity is 122 ± 8 gm/100 gm.
 - f) particle size is in the range of 220 μ -225 μ .
 - g) hexanal content is reduced from to 22 μ mole/gm from 64 μ mole/gm.
 - 25 h) the beany flavor of the soy protein concentrate is by 50%.
 - i) the product has all the amino acid contents retained as present in the starting defatted soy flakes.
 - j) the product has improved protein digestibility up to 88% .
 - k) the product has a shelf life of 180 days.