Pak. j. sci. ind. res., vol. 39, nos. 1-4, January-April 1996

PREPARATION OF AN ACTIVE FOAMING/WHIPPING AGENT FROM SOYBEAN MEAL

SURRUYA WADUD, SAIDA KOSAR, HUSSAN ARA, HAMIDA ABID AND N.A. SUFI
PCSIR Laboratories, P.O. Peshawar University, Peshawar, Pakistan

(Received June 20, 1993)

Foaming/whipping agent has been prepared from soybean meal using different proteolytic enzymes i.e. Alcalase, Neutrase, Papain and Pepsin. Optimum conditions such as time, temperature, pH of the reaction mixture have been worked out. The foaming agent prepared by the treatment of Pepsin on soybean meal possesses maximum whipping expansion and foam stability. The product is in powder form and possesses a good storage life upto two years.

Key words: Foaming/whipping agent, Soybean meal.

Introduction

The traditional whipping agent used is egg white, which is spray dried egg albumin. This is a typical natural product which possesses peculiar smell. Whipping agent with gelling property was prepared by Beckel *et al.* [1] by water extraction of soybean after removal of alcohol soluble components. Perri and Hazel [2] used hot lime for hydrolysing commercial soybean protein to produce foaming agent. Various proteolytic enzymes are known to modify both physical and chemical properties of protein so as to exhibit whipping or foaming properties. Cerili [3] has stated that soy-protein is superior to egg albumin as the latter coagulates in hot water and possesses peculiar smell. Soy protein products developed in recent years are used in place of egg albumin as sole aerating agents. Soybean meal, a rich source of protein has a potential to be used as a raw material for production of whipping agents. The object of the present study was to prepare foaming agent with good whipping properties utilising soybean meal.

Materials and Methods

The raw material used in all the experiments was hexane defatted soybean meal having protein contents 60% and oil 1%.

Preparation of foaming agent by treatment of soybean meal with alcalase and neutrase. Soybean meal (1 kg) was mixed with seven litre water. The pH of mixture was raised to 8.0 by dropwise addition of 0.5 N NaOH solution. Temperature was raised to 55°C and allowed to stand for an hour, enzyme alcalase (E/S = 2%) was added and incubated at 55°C for 15 min. The pH of the reaction mixture was maintained at 8.0. The reaction was stopped by bringing the pH of reaction mixture to 4.0. The reaction mixture was filtered and its pH was adjusted to 7.0, refiltered and concentrated under vacuum in a Rotary evaporator at 50°C. An experiment using Neutrase was performed as above except with the difference that in this case pH of the reaction mixture was maintained at 7.0.

Preparation of foaming agent from soy meal using papain. A 20.0% aqueous slurry of the soybean meal was prepared. Its pH was lowerd to 4.5, papain (0.5%) added and incubated at 65°C for 1 hr. It was then filtered and filtrate was concentrated under vacuum to 70° T.S.S.

Preparation of foaming agent from soymeal using pepsin. A slurry of soybean meal (1 kg) was prepared in water (3 lit), its pH was adjusted to 4.5 and was allowed to stand at room temperature for 1 hr and filtered. The residue was soaked in water (2 lit), pH lowered to 2.0 and pepsin (0.2%) was added and incubated at 37°C. Mixture was filtered and the pH of the filtrate was adjusted to 4.5, the precipitated material was centrifuged out. To the clear supernatent, carboxy-methycellulose (1.5%) was added and whisked in a Hobart Mixer, until a thick foam was formed. The foam was spread in stainless steel trays and dried in a shelf dryer at 55°C.

Determination of amino nitrogen. 2.0 g of soybean meal was dispersed in 150 ml of 0.2 M NaCl using laboratory blender for 2 mins. The blender was washed with 50 ml of 0.2 M NaCl and the washing liquid combined with the homogenised sample. pH was adjusted with 0.2 M HCl or 0.2 M NaOH and the dispersion was stirred with a magnetic stirrer for 1 hr. pH was regularly adjusted. At the end of the stirring period, the vo lume was determined, and 25 ml of the dispersion was centrifuged at 4000 RPM for 30 mins. The supernatents were analysed for nitrogen content by Kjeldahl procedure, and the percent nitrogen solubility was calculated as (soluble N%/total N% x 100).

Whipping expansion. Whipping expansion of all the samples was determined by preparing a 3.0% solution (dry matter basis) of the sample in water. 500ml of such solution was blended in a graduated blender-National Model MJ. 510 N at speed 2 for 5 min.

Whipping expansion of all Whipping expansion was calculated as follows [5].

$$\% \text{ whipping expansion} = \frac{\text{V-500 x 100}}{500}$$

V = Final volume of foam

Hydrolysis of soy protein using pepsin. During the hydrolysis of soy protein by pepsin at various time intervals at pH 2 and 37°C as shown in Fig. 3, the sample was removed and soluble nitrogen was determined [6]. For finding out the effect of temperature on the hydrolysis of soy protein by pepsin Fig. 4, the sample was removed at various time intervals. The amino nitrogen was determined at pH 2 at 20°, 30° and 37°C. For studying the effect of pH on the hydrolysis, Fig. 5, amino nitrogen was determined at various time intervals at pH 2, pH 2.5 and pH 3.0 at 37°C.

Dialysis of the foaming agent. In order to remove the salts produced during the pH adjustments, 500 ml of the reaction mixture was dialysed at 25°C using the dialysis tubing (Viskings tubing 36/32, the Scientific Instrument Centre Limited, London) for 18 hrs.

Analytical work. All the samples were analysed for protein [6], amino nitrogen, moisture, salt and ash content [7].

Results and Discussion

Foaming/whipping agent prepared by the treatment of Alcalase on soybean meal at constant pH stat was in the form of a dark brown liquid concentrate of 70° Brix, possessed slight bitter taste and whipping expansion 60% (Fig. 1). Foaming agent prepared by the treatment of Neutrase and papain on soybean meal was also dark coloured liquid of 70° Brix and had whipping expansion 38% and 24% respectively. The foaming agent prepared by the treatment of pepsin on soybean meal was a liquid concentrate of 70° Brix, possessed light cream colour which was converted into a cream white powder and has the whipping expansion 90% (Fig. 1). It is dispersible in water and effective in foam-mat drying of many food products i.e. onion, garlic, tomato, vinegar, soy sauce, guava, Mango Honey etc.

Samples of foaming agent using various enzymes on soybean meal were prepared in the form of liquid concentrate

TABLE 1. ANALYSIS OF FOAMING AGENT PREPARED BY THE TREATMENT OF DIFFERENT ENZYMES ON SOYBEAN MEAL.

	Pepsin	Alcalase	Neutrase	Papain
Protein	45%	36.5%	30.4%	25.0%
Moisture	6%	30.0%	30.0%	30.0%
Salt	13.16%	14.0%	17.0%	15.0%
Ash	7.0%	7.5%	8.0%	7.7%
N free extract	28.84%	12.0%	14.6	22.3%

TABLE 2. ANALYSIS OF FOAMING AGENT.*

	Before dialysis	After dialysis
Protein	45.0%	52.5%
Moisture	6.0%	5.5%
Salt	13.16%	3.7%
Ash	7.0	3.5%
N. free extract	28.84%	34.8%

*Prepared by pepsin at pH:2.0, temp. 37°C time:18 hours (on dry weight basis).

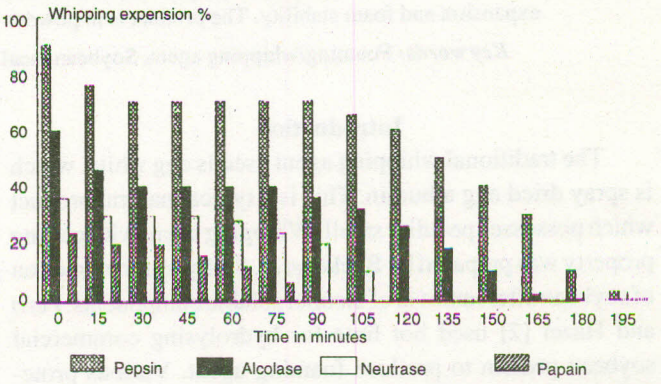

Fig. 1. Whipping expansion of foaming agent.

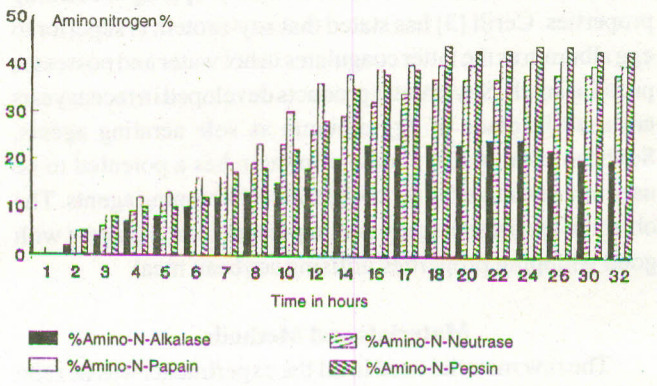

Fig. 2. Degree of hydrolysis DH of Alcalase and Neutrase.

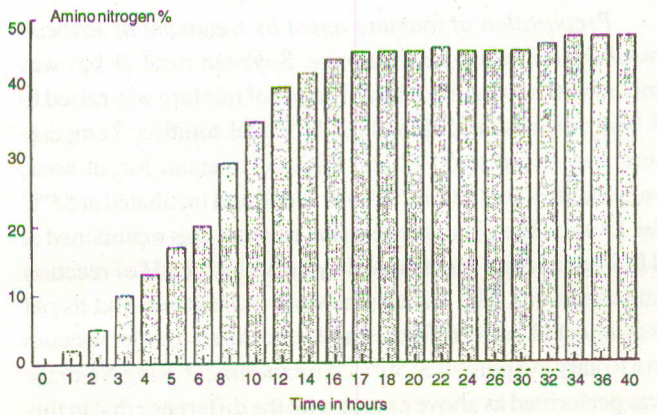

Fig. 3. Effect of time on hydrolysis of soy protein by pepsin.

of 70° Brix and a comparative analysis is shown in Table 1. The foaming agent concentrate prepared by the pepsin was dried in the form of an odourless cream white powder. As this powder was salty in taste, it was dialysed using a dialysis tubing by which salt content was reduced from 13.16 to 3.7% and protein content increased from 45% to 52.5%. Analysis of dialysed and un-dialysed samples is shown in Table 2.

Hydrolysis curve. The % amino nitrogen was plotted vs. time in hours as shown in Fig. 2. The maximum value of amino nitrogen produced by the action of alcalase on soymeal is 22.0% after 22 hours, 38% by neutrase after 24 hrs, 40% by papain after 22 hrs and 44% by pepsin after 18 hrs.

Effect of different parameters on the hydrolysis of soybean meal by pepsin. As shown in Fig. 3, the amino nitrogen was plotted against time during hydrolysis at 37°C. The amino nitrogen increased with the increase in time. The hydrolysis was maximum at 18 hrs and after 18 hrs the increase was very negligible.

Effect of temperature. The foaming agent was prepared and amino nitrogen produced during the hydrolysis was plotted vs time at 20°, 30° and 37°C at pH 2.0 (Fig. 4). The amino nitrogen was maximum at 37°C for 18 hrs.

Effect of pH. The foaming agent was prepared at pH 2.0, 2.5 and 3.0 at 37°C for 18 hr. and amino nitrogen was plotted

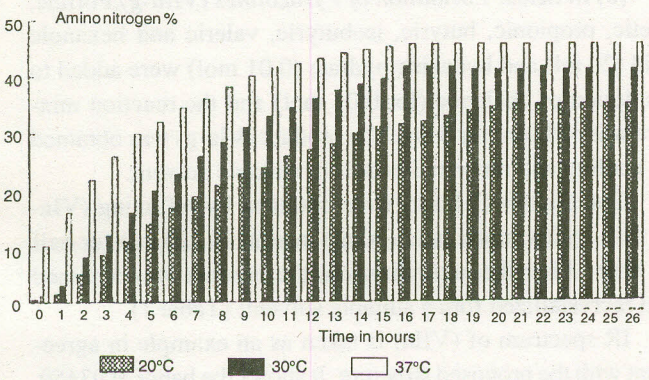

Fig. 4. Effect of temperature on the hydrolysis of soy protein by pepsin.

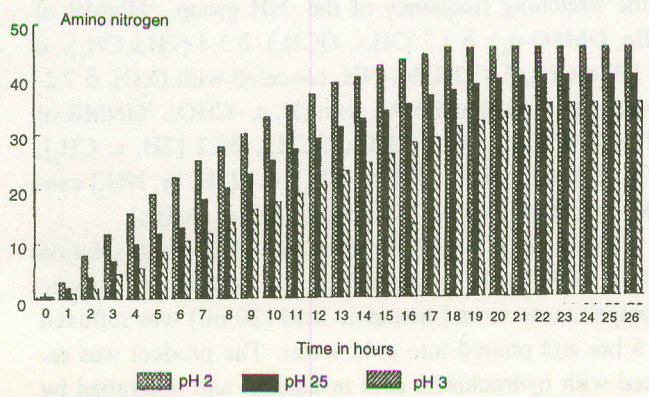

Fig. 5. Effect of pH on the hydrolysis of soy protein by pepsin.

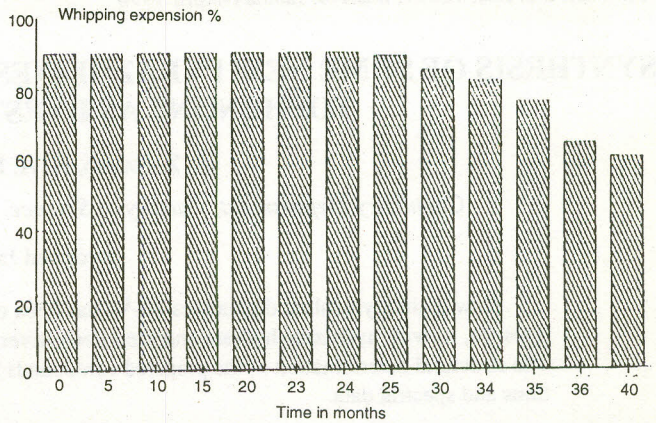

Fig. 6. Effect of storage time on the whipping property of the foaming agent.

vs time. The amino nitrogen increased in the beginning of the hydrolysis and became constant. The hydrolysis as measured by amino nitrogen at various pH values is maximum at pH 2.0.

Whipping expansion. The percent whipping expansion for all the samples prepared by various enzymes was estimated as shown in Fig. 1. It is maximum in case of whipping agent prepared by pepsin. The whipping expansion decreases slightly in the initial 15 mins and remains stable for another 75 mins then gradually decreases.

Storage life. Storage life studies were carried out for a period of three years. After every two months whipping expansion was estimated as shown in Fig. 6. The whipping expansion remained constant for a period of two years after which it started to decrease.

Acknowledgement. Thanks are due to Mr. Khaliluddin Shahzad, Laboratory Assistant and Muhammad Younus Khan , S.O. for making computer prints of various graphs.

References

1. A.C. Beckel, L.I. Devoss, P.A. Belter and A.B. Smith, U.S. Patent 2, 444 241.
2. J.M. Perri, F. Hazal, Ind. Eng. Chem., **38**, 549.
3. Carili *et al.*, Candy Industry, **6**(11), 27 (1947).
4. Olson *et al.*, Application of proteolytic enzymes for the production of high protein low cost foods. Novo, Ind. Res. Institute 2880 Bagsvereod (1979).
5. J.A. Nisson, H.S. Olson, Influence of Peptide Chain Length on the Taste and Functional Properties of Enzyme Modified Soyprotein AC5, symp., 92-125-146 (1979).
6. AOAC Association Official Analytical Chemists, Washington D.C., 1970. 12th ed.
7. H.E. Cox, D. Pearson, Chemical Analysis of Food. (Chemical Publishing Company Inc., New York, 1962.)
8. J.R. Nicholis "Aids to Analysis of Foods Drugs. International Chemical Ser., Woodman, 7th ed.