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DEVELOPMENT OF A PROCESS FOR THE PREPARATION OF SOY CURD (TOFU)

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Various conditions for the preparation of soymilk from soybean such as bean water ratio, total soluble solids have been worked out. Effect of concentration, coagulation temperature and nature of coagulant used have been optimised. The coagulant used were calcium sulphate, Magnesium sulphate, calcium chloride, citric acid, lactic acid and acetic acid. The product prepared by coagulation with calcium sulphate gave maximum yield of protein 32.1% and fat 7.9% (dry basis). All the products were subjected to analytical and organoleptic evaluations. The product prepared by calcium sulphate coagulation method was highly acceptable.

Key words: Processed soy products.

Introduction

In past few years traditional animal protein sources such as milk, cheese and eggs have sharply risen in price and there is also shortage of good quality protein in the country. To overcome the short supply of protein, the use of soybean products, soymilk, soy curd, soy youghurt is becoming important. One such product is soy curd (Tofu). Tofu originally stems from China. It has been a low-cost protein staple food of the South East Asian diet for more than 2000 years. It has been discovered by a Chinese Prince in 164 B.C. The spread of tofu to western world and even to the rest of Asia is more recent. It is being used in many western style dishes including dressings, spreads, slads, sand wiches, soups, egg dishes and vegetable dishes and can serve as the key to delicious meatless dishes. Nutritionally it is a good source of low cost high quality protein free of cholestrol and low in saturated fats. It is an ideal food; an eight ounce serving contains 147 calories, an equal weight of four eggs. It is also rich in Iron, and contains a healthy balance of minerals and some vitamins. It has the texture of cottage cheese prepared from fresh milk and possess bland tests. It is highly digestable food.

Present research have been carried out to prepare a product from soybean using different coagulants i.e. acetic acid, lactic acid, citric acid, magnesium sulphate, calcium sulphate and calcium chloride. The sensory evaluations of the product have been carried out. Different products have been prepared from soy curd according to local taste.

Materials and Methods

Soybean used for the preparation of soycheese were Bragg variety cultivated at Swat (1985) having protein contents 45.16% and oil 21.82% moisture 6.2%, carbohydrates 22.62% and ash contents 4.2%. The coagulants used were calcium sulphate, calcium chloride, magnesium sulphate, citric acid, lactic acid and acetic acid.

Curd making mould. A rectangular stain less steel tray (Fig. 6) 13" x 9.5" x 2.5" having holes of 1/2" dia on all sides of the mould.

Wooden lid. The wooden lid used was of 12.5" x 9.25" x 5" with handle.

Preparation of soymilk. Soybeans were cleaned, washed and soaked in tap water at room temperature for 12-16 hours then passed through grinding mill along with water. The experiment was repeated with 1:5, 1:6, 1:7 and 1:8 bean water ratios (Table 1). The mash was filtered through cheese cloth or centrifuged. This milky filterate is soymilk.

Coagulation of soybean milk. Soymilk was heated to 80-85° with constant stirring. Then 20% solution or suspention of the coagulant was added slowly with gentle mixing by a spoon to prevent the break down of the curd that forms. The milk was kept at this temperature until all the protein is precipitated and the whey is separated and the curd settles down.

When the curd settled, it was transferred to the cheese making mould lined with markin cloth. The corners of the cloth was folded over the curd, covered with wooden lid and one kilogram weights (divided into four weights of 250.0 each for every 1 kg of curd were placed over it to press the coagulated mass. The pressed curd was like cottage cheese Fig. 1, 2 and 3. The final product was weighed, storage life of the product was studied at room temperature, under refrigeration and in deep freezer.

Analytical work. (1) Moisture contents were determined in the sample by AOAC methods. (2) The protein contents were estimated as total N x 6.25 using Kjeldahls method. (3) Fat was estimated by Soxhlet extraction using petroleum ether 60-70°. (4). Ash contents were determined [7]. (5) Carbohydrate values have been calculated by difference.

Organoleptic evaluations. The samples of soy curd prepared by citric acid, calcium sulphate and calcium chloride were organoleptically evaluated cottage cheese was used as a reference. The products were served to a panel of eight judges. The acceptability i.e. average score of five parameter colour, flavour, taste, texture and chewing property

of the products was calculated as follows:

$$\text{Acceptability (\%)} = \frac{\text{Average of five parameters}}{50} \times 100$$

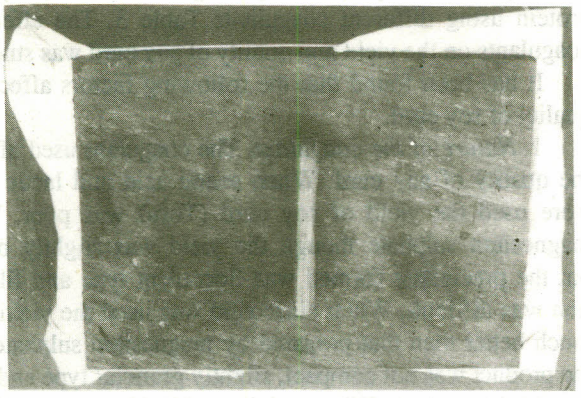


Fig. 1. Cheese making mould.

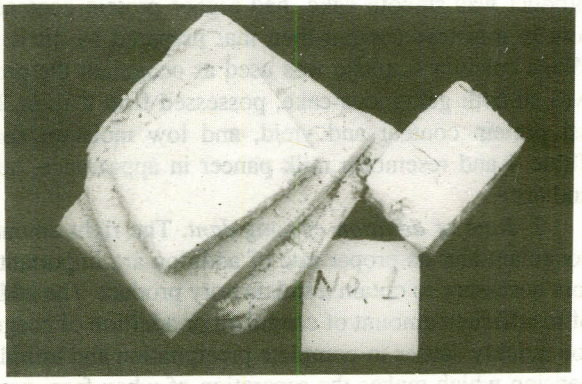


Fig. 2. Soy cheese prepared by calcium sulphate precipitation.

Fig. 3. Soy cheese prepared by calcium chloride precipitation.

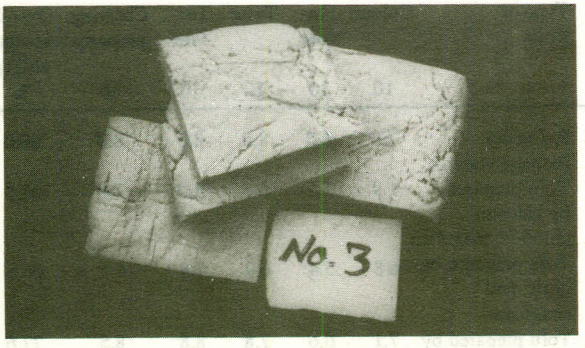


Fig. 4. Soy cheese prepared by citric acid precipitation.

Statistical analysis. The data collected was statistically evaluated using analysis of variance based on completely randomised design and difference in mean values were tested by Duncan's multiple range test [9]. Results are shown in Table 5.

Tofu pakoras. Tofu was cut into suitable size pieces dipped in spiced water for 10 minutes and coated with basin (gramdal powder) and deep fat fried.

Tofu curry. Onion was roasted in vegetable ghee, then garlic, red pepper salt and tomatoes were added and roasted for half minute then water was added and boiled for 5 minutes. To this soup Tofu pieces of sugar cube size were added and cooked for 10 minutes. Fig. 4 and 5.

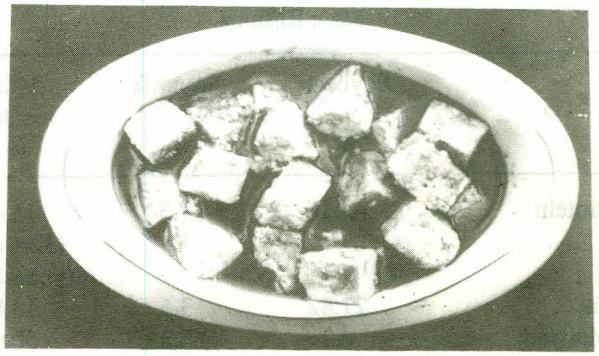


Fig. 5. Soy cheese curry.

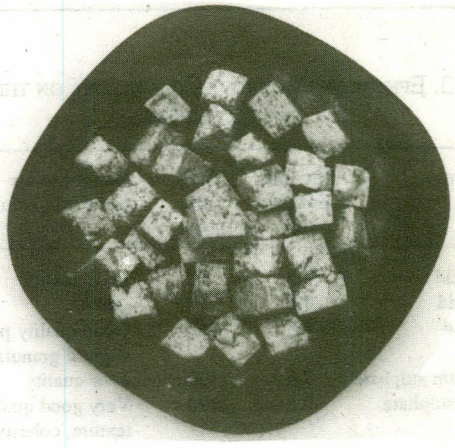


Fig. 6. Soy cheese curry.

Roasted Tofu. Spices i.e. cumin seed, black pepper, salt and garlic were added to the yoghurt and flat pieces of Tofu were dipped for 10 minutes and fat fried.

Results and Discussion

The effect of bean. Water ratio on the total soluble solids of milk and protein has been studied as given in Table 1. Maximum extraction of soluble solids and protein occurs when 1:5 bean: water ratio is taken but the filteration is very difficult therefore 1:6 bean water ratio was used.

Analysis of soybean, soymilk and milk residue as given in Table 2 shows that soybean contains 45% protein

TABLE 1.

Bean: Water	Total soluble solids %	Protein %
1:8	8.0	6.0
1:7	8.7	6.5
1:6	11.0	7.5
1:5	12.1	8.8

TABLE 2. ANALYSIS OF SOYBEAN, SOYBEAN MILK AND MILK RESIDUE.

	Soybean %	Soymilk %	Milk residue %
Protein	45.16	7.5	15.4 (32.4 on dry .basis)
Fat	21.82	3.5	13.88
Moisture	6.2	85.3	50.6
Carbohydrate	22.62	3.15	17.0
Ash	4.2	0.55	3.12

TABLE 3. EFFECT OF DIFFERENT COAGULANTS ON THE YIELD OF SOY CURD (TOFU).

Coagulant	Soymilk protein (%)	Yield litre (g)	Quality of the soy curd (Tofu)
Acetic acid	7.5	60	Poor quality
Lactic acid	7.5	70	- do -
Citric acid	7.5	160	Good quality product slightly granular
Magnesium sulphate	7.5	100	Poor quality
Calcium sulphate	7.5	190	Very good quality smooth texture, cohesive and gelatinous
Calcium chloride	7.5	177	Good quality

TABLE 4. COMPOSITION OF SOY CURD PREPARED BY DIFFERENT COAGULANTS.

Composition of soy curd	Calcium chloride (%)	Calcium sulphate (%)	Citric acid (%)
Protein	9.16	15.40	6.40
Fat	10.90	7.60	10.30
Moisture	60.50	52.00	65.00
Carbohydrates	18.44	24.40	17.80
Ash	1.00	0.60	0.50

out of which 7.5% is extracted in soymilk along with 3.5% fat and 3% carbohydrate.

Soy curd was prepared by coagulation of the soymilk protein using different coagulants Table 3. The effect of coagulants on the yield and quality of soy curd was studied.

It has been found that the following factors affect the quality of soy curd.

1. *Nature of the coagulant.* The coagulant used affects the quality of soy curd. When acetic acid and lactic acid were used the yield of soy curd (Tofu) was poor. With magnesium sulphate though the yield was slightly better but the precipitate formed was flocculent type and filteration was difficult. When citric acid was used the yield was much better than that prepared by magnesium sulphate but the product was not compact, slightly granular type and low in protein content. When calcium chloride was used, the product was smooth cake, had higher protein content and low in moisture content then that prepared by citric acid. When calcium sulphate was used as coagulant the product was smooth gelatinous cake, possessed firm texture, highest protein content and yield, and low moisture content Table 4 and resembles milk paneer in appearance, texture and taste.

2. *Rate of addition of coagulant.* The right amount of coagulant and its proper rate of addition are important factors necessary to obtain a satisfactory product. The addition of insufficient amount of coagulant or addition of coagulant too quickly causes in-complete precipitation and turbid suspension which makes the separation of whey from precipitate difficult and low yield of soy curd.

3. *Duration of heating.* Heating of soymilk before the addition of coagulant affect the quality of soy curd. It was observed that heating of soymilk for 8-10 minutes at 80-85° resulted in good quality product. Insufficient heating time results in less cohesive mass, while longer heating period i.e. more than 10 minutes causes granular texture of the product.

4. *Right amount of pressure for separation of whey.* Proper loading of weight also affect the texture of the fin-

TABLE 5. ORGANOLEPTIC EVALUATIONS.

S. No.	Type of Tofu	Colour 10	Flavour 10	Taste 10	Texture 10	Chewing property 10	Overall acceptability %
1.	Reference (cottage cheese)	7.5	8.0	8.5	8.0	8.0	80.0
2.	Tofu prepared by calcium chloride coagulant	6.9	5.5	6.5	5.0	7.0	61.8
3.	Tofu prepared by citric acid coagulant	6.8	5.4	6.9	7.8	6.5	66.8
4.	Tofu prepared by calcium sulphate	7.1	6.6	7.8	8.8	8.5	77.6

ished product. In case of coagulation with calcium sulphate one litre of soymilk yields 190 g of Tofu (52% moisture) when 1 kg pressure in four equally divided weights is applied. When 500 g weight is applied yield is 220 g (59% moisture), when 1500 g pressure is applied yield is 170 g Tofu with 47% moisture. The pressed cake was cut into slices and the cut surfaces were compared with the cottage cheese and it was found that 1 kg pressure yields a product which is more similar to the cottage cheese.

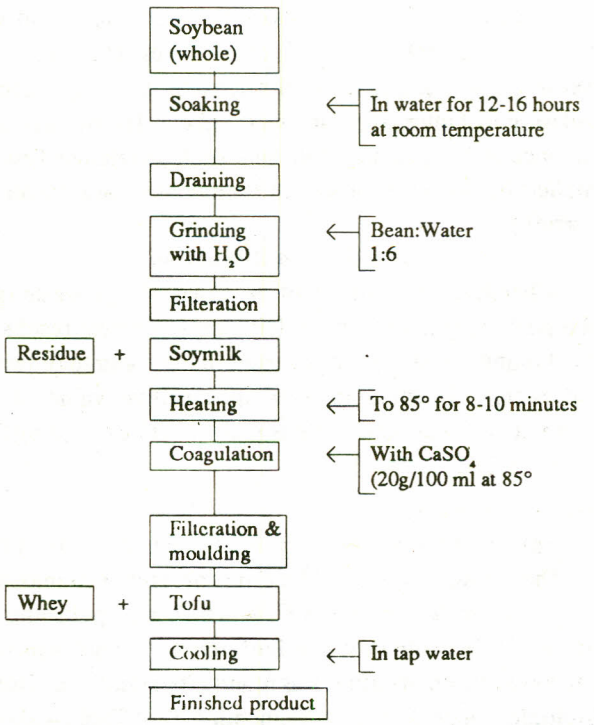
The data regarding organoleptic evaluation of cottage cheese and Tofu prepared by different coagulants when subjected to statistical analysis showed that overall acceptability of sample No. 1 and No. 4 was significantly different from sample No. 2 and 3 where as sample No. 4 and No. 1 showed non significant difference at 5% level ($P < 3.84$). Results were also tested using analysis of variance by Duncun's multiple range test which showed that the calculated values of No. 1 and No. 4 at 5% level are greater than tabulated, where as the values for No. 2 and No. 3 are less than the tabulated values. Moreover values for No. 1 and No. 4 showed non-significant difference with each other.

Storage life of the product was determined at room temperature (20-220°), under refrigeration (8-10°) and in the deep freezer (–18°).

The product has a storage life of 20-24 hours at room temperature, three to four days in the refrigerator, where as in the deep frezeer it loses it texture and the colour darkens from cream white to light yellow.

In order to find out the applications of Tofu in our daily diet, various dishes like Tofu pikoras, Tofu curry and roasted tofu have been prepared and it has been found that tofu can be used as a substitute for cottage cheese.

FLOW DIAGRAM:



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