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STUDIES ON THE PREPARATION OF MEAT SUBSTITUTE FROM SOYBEAN

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A vegetable base high protein product closely resembling minced meat in taste, texture and appearance was prepared from soybean. It contains 60% protein, 25% oil and 5% ash on dry wt. basis. Different acids have been used for the isolation of soy protein from soybean. The percentage yield and quality of the product was better when prepared by citric acid precipitation. Various flavourings, supplementary nutrients and edible colours were added to give it a taste and appearance similar to that of minced meat. NPU and PER values have been determined on rat feeding for 4 weeks which confirmed that the product is as nutritive as meat.

Key words: Soybean, Meat, Protein, Vegetable.

Introduction

Proteins are essential constituents of the human diet. Despite the obvious value of legume foods in nutrition, which are rich in protein, they compete poorly with foods of animal origin even though the latter are far more expensive. But for a great number of people whose income is very low, the increasing cost of animal foods forces a reconsideration of the amount of resources that can be spent on the more expensive foods [1].

Moreover, in some countries the population is rapidly increasing and the animal protein supply is becoming insufficient. This deficiency will go on increasing in view of the fact that the conversion of crops into animals is an expensive and a slow process [2].

Several methods have been developed for the production of spun fibre protein [3] which closely resembles natural meat. The process comprises preparing a quantity of filament of protein material by dispersing protein material in suitable dispersing medium where-in the protein is solubilized forcing the dispersing medium through a spinneret and passing the stream-lets obtained thereby into a coagulatory bath, which is generally an acid salt solution. Streams coming through the spinnerets are thus precipitated in the form of filaments, the filaments are treated with edible binders passed through melted fat and made into small meat chunks. The product prepared closely resembles natural meat as to its appearance, colour, flavour, fiberous qualities, chewiness and nutritive value but the method is not simple and is very costly [4].

The object of present work is to develop a process for the production of meat substitute which is relatively cheap and can be carried out very easily on a continuous basis. It is easy to handle, to store to ship and to prepare under proper conditions. It is also lean and due to the presence of polyunsaturates it is preferable for the persons suffering from high blood cholesterol.

Materials and Methods

Soybeans used were of lee variety cultivated at Swat during 1987. The beans were sorted to remove stalks, stones and damaged grains, soaked for an overnight in tap water at room temperature, ground with water in a pin grinder and the slurry was filtered through muslin cloth. The filterate was heated to boiling and precipitated with: (1) Lactic acid (conc) (2) Acetic acid (conc), (3) hydrochloric acid (conc), (4) citric acid saturated solution, till clear whey separates, washed with water to remove excess acid colours caramel 0.05% red 0.025% and yellow 0.015% were added filtered and monosodium glutamate 0.5%, yeast extract = 0.35%, salt 1%. Butylated hydroxyanisole 0.02% were added. The product was dehydrated at 60° for 10-12 hrs to 6.5% moisture in a cabinet type dehydrator (Model No. 6298 M. fchells). Beef was also minced and dehydrated to the same moisture content.

Analytical work. Meat substitute was analysed for total protein, oil, moisture, ash content, urease activity and peroxide value. Protein was determined by Kjeldahl method, moisture content, ash content by AOAC [5] and peroxide value and urease activity by AACC method [6].

Bacteriological status. Product was examined microbiologically for total count, yeast and mould, total coliform, *E. Coli*, *Salmonella* and *Shigella*.

Total count was determined by using nutrient agar, yeast extract and mould count was carried out on malt extract agar, coliform and *E. Coli* on lactose broth, *Salmonella* on Bismuth sulphite agar [7] and *Shigella* on Macconkey's and desoxycholate citrate agar [8].

Rehydration and cooking. 100 Grams of meat substitute was soaked in 400 ml of water for half an hr. 50 Grams of onion was sliced and roasted in 100 gm of vegetable ghee till light brown. 35 Grams ground garlic, 1/2 tea spoon red peppers, one tea spoonful salt and 125 gm of tomatoes were added and roasted for one to two minutes.

The soaked meat along with water was added to the above material and cooked for 10 mins. The small amount of green peppers, corriander cardamum large and cumin seeds were added and again cooked for 1 min.

Organoleptic evaluation. The samples of soy meat prepared by acetic acid, lactic acid, hydrochloric acid and citric acid were organoleptically evaluated [9]. Beef was used as a reference. The product was served to a panel of 12 judges on three separate days and mean score of every product was calculated. The acceptability, average score of 5 parameters, colour, flavour, texture taste and chewing property of the product was calculated as follows:-

$$\text{Acceptability \%} = \frac{\text{Average of 5 parameter x 100}}{50}$$

Statistical analysis. The data collected was statistically evaluated using analysis of variance and the difference in the mean values was tested by Duncan's multiple range test [10], results are shown in Table 1.

BIOLOGICAL EVALUATION

Determination of protein efficiency ratio (PER). For finding the protein efficiency ratio of meat substitute twelve albino rats weighing 160 gm each were divided into 3 groups, one group was kept as control and the other two groups were given meat substitute and minced meat respectively alongwith their normal non-nitrogenous diet. Feeding was continued for a period of 30 days and record of food intake and weight gain was maintained, PER was calculated by dividing the Wt. gain with protein consumed during the experimental period [11].

Determination of net protein utilization (NPU%). For the determination of NPU 12 albino, rats of 240 gm each were divided into three groups. One group was kept as control, to the 2nd group minced beef and to the 3rd group soymeat was fed alongwith the normal non-nitrogenous diet. After every 24 hrs faeces and urine were collected for 4 days, mixed, thoroughly and nitrogen was estimated by Kjeldahl method Table 5.

$$\text{NPU} = \text{Digestibility x BV}$$

$$\text{NPU} = \frac{\text{1-(F-M)-(U-UK) x 100}}{\text{I}}$$

Results and Discussion

All the products were analysed for moisture, total protein, oil, ash content, urease activity and peroxide value Table 1. It was observed that the total protein, oil content and percentage yield were greater in the case of sample no. 4 as compared to other meat substitute. Urease activity and peroxide values are within the required value.

Organoleptic evaluation. All the 5 samples were organoleptically evaluated by 12 judges on three separate days and mean score for each product was calculated. Mean score of these judges for appearance, flavour taste, texture and chewiness was recorded.

The data regarding organoleptic evaluation of meat substitute prepared by different acids when subjected to statistical analysis showed that overall acceptability of sample no. 4 (Fig. 1) was significantly different from other three samples at 5% level.

Results were also tested using analysis of variance by Duncan's multiple range test which showed that the calculated values of sample no. 4 are greater than the tabulated values at 5% level and that sample nos. 1, 2 and 3 are less than the tabulated values.

Bacteriological status. The overall bacteriological status of all the products were satisfactory. The low total count of all

TABLE 1. SOY MEAT ANALYSIS.

S. No.	Moisture %	Protein %	Oil %	Ash %	Urease pH change	Peroxide value Meg/kg	Yield %
1.	6.7	52.8	21.0	5.06	0.02	17.0	20
2.	6.5	55.3	20.3	5.0	0.04	15.0	35
3.	6.8	51.2	20.9	5.1	0.03	16.0	40
4.	6.5	60.0	21.5	4.9	0.05	15.9	60
5. Beef	7.0	70.0	–	3.3	0.00	14.0	–

TABLE 2. ORGANOLEPTIC EVALUATION (MEAN SCORE OF 12 JUDGES ON THREE SEPARATE DAYS).

S. No.	Appearanct (10)	Flavour (10)	Texture (10)	Taste (10)	Chewiness (10)	Total (50)	%
1.	6.0	5.0	5.0	5.0	5.0	26.0	52.0
2.	6.5	5.5	6.0	5.0	5.0	28.0	56.0
3.	7.0	5.0	5.0	4.0	4.0	25.0	50.0
4.	8.0	7.9	9.0	8.5	8.0	41.4	82.0
5. Beef	9.0	9.0	9.0	9.0	9.0	45.0	90.0

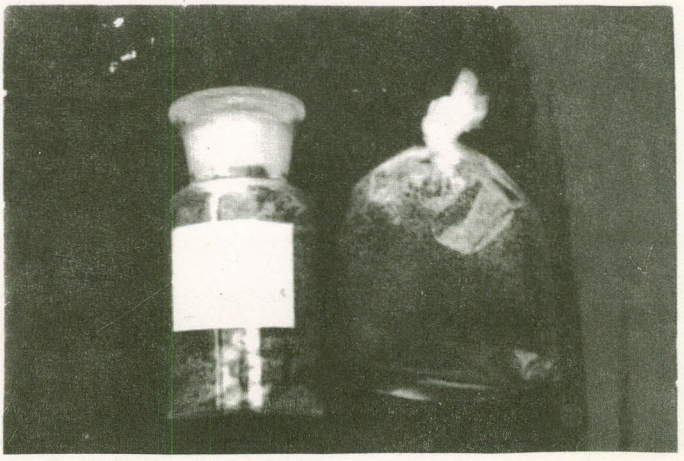

Fig. 1. Sample of meat substitute.

the samples as shown in Table 3 indicates that the sanitary conditions are suitable for the process.

Nutritional evaluation of the product. The results of both the protein efficiency ratio Table 4 and NPU Table 5 in rat feeding indicates that the products are of the same values as that of minced meat.

TABLE 3. MICROBIOLOGICAL STATUS NUMBER OF ORGANISMS PER GRAM OF SAMPLE.

S. No.	Total count bacteria/ml	Yeast & mould	Total Col: MPN	*Salmonella*	*E.Coli*	*Shigella*
1.	100	Nil	5	0	Nil	Nil
2.	70	"	6	0	"	"
3.	80	"	4	0	"	"
4.	65	"	2	0	"	"
5.	200	"	2	0	"	"

TABLE 4. DETERMINATION OF PROTEIN EFFICIENCY RATIO OF SOY MEAT SAMPLE NO. 4.

Source of protein	Total protein intake	Wt. gain	PER
Soy meat (sample No. 4)	12 gm	42.0 gm	3.5
Beef	12 gm	43.2 gm	3.6

TABLE 5. DETERMINATION OF NPU OF SOY MEAT (SAMPLE NO. 4).

Source of protein	Total protein intake	Protein in faeces	Protein in urine	NPU %
Soy meat (Sample No.4)	12 gm	4.0 gm	0.008gm	65.5
Beef	12 gm	3.59 gm	0.006gm	70.0%

Conclusion

The product resembles dried minced meat which after hydration and cooking possesses a chewing characteristic approaching that of meat. This is an all vegetable protein and is especially suited to dietry foods where vegetable origin and control of fat content are of prime importance. It can be used for the preparation of palatable and nutritious dishes with vegetables and rice and is an excellent enrichment for casser-roles, patties, meat balls, sandwich fillings, burgers and convenience foods and is really a meat substitute on meatless days.

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