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DEHYDRATION STUDIES ON THE PRESERVATION OF TEMPEH

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Tempeh was prepared from Soybean cultivated in Pakistan by fermentation with *Rhizopus oligosporus* NRRL-2710 slices of different sizes were prepared and the samples were steamed for 3,5,7,5 and 10 min. and dehydrated to 4, 6-4.8% final moisture content. Steaming for 5 min. from both the sides showed better results. Protein content and rehydration ratio gradually decreased during 120 days storage of the dehydrated tempeh but the product remained acceptable for 4 months and rehydrated to almost original size, taste and texture.

Key words: Dehydrated soy product.

Introduction

Tempeh a meat analogue and source of vitamin B-12 (generally lacking in vegetarian diet) is a product made by fermenting soaked, dehulled, partially cooked soybean [1] with Rhizopus oligosporus at 31° for 20-24 hr. The product has been used in large quantities for its nutritious and palatable properties in the diet of millions of oriental people for many centuries. Previous investigations for the preservation of tempeh were carried out by fermenting soybean, immediately after inoculation with tempeh culture of the processed soybean and then was stored at low temperature. Studies were also conducted to find out the possibility of low temperature storage of inoculated soybean filled in perforated plastic containers. Thus when fresh tempeh would be needed the fermentation bags could be removed from low temperature and the inoculated beans allowed to ferment [2]. The material ready for fermentation could be stored for one day in a refrigerator at 5-6° or for 1-4 weeks in a deep freezer at 10°. The bags were removed from the refrigerator or deep freezer and incubated at 31°. The products were very satisfactory. The fermentation time was about 21-22 hr for the bags stored in a refrigerator temperature and 36-38 hr for the bags stored frozen. In fact the time of fermentation in the latter case was much greater since the soybeans required several hours to attain the temperature of the incubator. Therefore there seemed to be a research need to identify a more effective and economical method for tempeh preservation. Present studies have been carried out on the dehydration/rehydration of tempeh. This may be an alternative way in which the product can be preserved.

Material and Methods

Soybean cultivated at Swat during 1985 were used for present studies. The moisture content was 6, 15% ± 0.7 contained 28.5 ±.0.2% oil and 44± 0.4%.

Preparation of tempeh. The beans were sorted to remove damage grains, sand and husks. Tempeh was prepared in preforated small trays of size 2 cm placed in large trays [3] and tempeh cake was cut into slices of 0.5", 1", 1.5" and 2" of width.

Steaming. The slices were steamed (Fig. 1) for 3,5,7.5 and 10 min. from one side. The same experiment was repeated by steaming the product from the other side for another 3,5,7.5 and 10 min. repsectively.

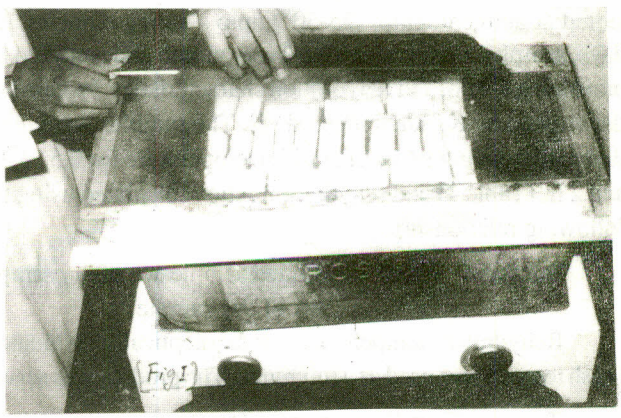

Fig. 1. Steaming of tempeh slices.

For this purpose an aluminium Tub 2',2" x 1.5" x 8" was filled with 2/3 vol of water. A stainless steel sieve 10" x 18" fixed in a wooden frame was placed over the tub and tempeh slices were put on the top of the sieve 9 kg/m² covered with a lid and heated with steam.

Dehydration. The slices were loaded on to drier trays at the rate of 9 kg/m² and placed in a cabinet type dehydrator (Model Mitchell Dryers Ref. No. 6298/69), Drying time varied from 210 to 30 min. (Fig. 2). The optimum drying conditions were determined after a series of preliminary experiments. Product was dehydrated to same moisture content at different temperatures for different length of time. Dehydrated sample was organoleptically evaluated for the colour, flavour, appearance and taste by a panel of expert judges. The results of triplicate observations were reported (Table 1).

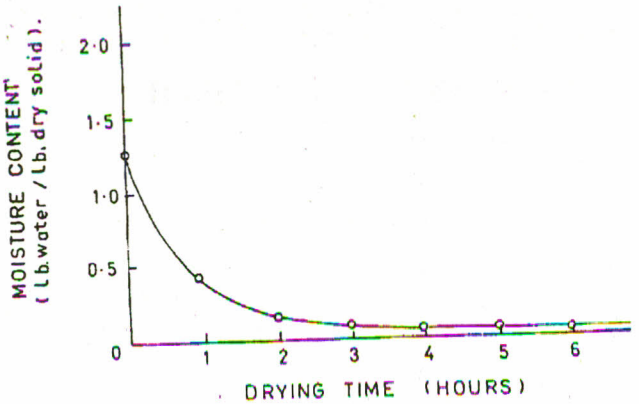

Fig.2. Drying rate curve of Tempeh.

Drying rate determination. Three trays of each of the sample of the slice size 0.5", 1.0", 1.4" and 2.0" were taken. Average weight of the 3 trays from each lot was used for drying rate calculations. Net weight of the sample was determined initially and at 30 min. intervals during the drying operation. A drying rate curve was drawn [4].

Quality evaluation and chemical analysis. Dehydrated samples were placed in polyethylene bags of 3thou, thickness stored at ambient temp. (25-30°) upto a storage time of 120 days, samples were drawn after every month and analysed for moisture, protein, and rehydration characteristics. Protein was determined by Kjeldahl method [5]. The samples were rehydrated by soaking in water at room temperature for 0.5, 1,1.5 and 2 hr (Table 1) and rehydration ratios calculated using the following relationship.

$$\text{R.Ratio} = \frac{\text{Wt. of rehydrated sample-wt. of dry sample}}{\text{wt. of dry sample}}$$

Rehydrated tempeh was organoleptically evaluated. Fresh tempeh was used as a reference. The product was served to a panel of judjes. The acceptability i.e. average score of fine parameters i.e. colour, flavour, taste, texture and shape of the product was calculated as follows:

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

TABLE 1. TIME /TEMPERATURE DETERMINATION FOR DEHYDRATION OF TEMPEH.

Temp. (°C)	Drying time (hr)	Moisture (%)	Quality of dehydrated product
80	5	4.5	Not acceptable
70	6	4.3	"
60	7	4.6	Acceptable
50	10	4.8	Not acceptable

Results and Discussion

Determination of optimum drying conditions. Preliminary experiments were conducted to determine suitable drying time and temperatures, so that dehydrated tempeh of acceptable quality could be produced (Table 2).

Drying rate curve shows that the ratio of dehydration is very high in first 2 hr, goes on decreasing till it is constant after 6 hr.

Low rehydration ratios and hard texture of the finished product were the major problems to overcome. Experiment conducted to achieve dehydrated tempeh of acceptable quality revealed that it was necessary to dehydrate the sample after steaming the slices of tempeh for different length of time. It was observed that steaming from one side did not give good textured product. Furthermore steaming for 3,7.5, 10 mins. also gave un-acceptable product. But when the slices were steamed for 5 min. from each side the product gave greater rehydration properties and texture resembled the fresh tempeh (Table 3).

Effect of dehydration and storage on the quality of Tempeh. Moisture content. All the samples showed an increase in moisture content during 120 days storage at ambient temperature (Table 4). At the termination of storage time there was an increase in the moisture content from 4.5,

TABLE 3. EFFECT OF STEAMING TIME ON THE QUALITY OF DEHYDRATED TEMPEH.

Slice	Steaming for			
	3min.	5min.	7.5min.	10 min.
0.5"	Un-acceptable	acceptable	Not acceptable	Notaccceptable
1.0"	"	"	"	"
1.5"	"	"	"	"
2.0	"	"	"	"

TABLE 2. EFFECT OF REHYDRATION ON THE QUALITY OF TEMPEH.

Sample size	%Rehydration after 30 min.	Acceptability	%Rehydration after 60 min.	Acceptability	%Rehydration after 90 min	Acceptability	%Rehydration after 120 min	Acceptability
0.5" width	60%	Not acceptable	70%	Not acceptable	72%	Slightly acceptable	75%	Highly acceptable
1.0"	67%	"	72%	"	78%	"	79%	"
1.5"	67%	"	79%	"	80%	"	84%	"
2.0"	75%	"	89%	"	82%	"	84%	"

TABLE 4. EFFECT OF SIZE OF SLICE AND STORAGE TIME ON MOISTURE CONTENT, PROTEIN CONTENT, REHYDRATION RATIO.

S. No.		Fresh temph	Dehydrated tempeh Storage 0	30 days	60days	90days	120days	Appearance of final product
	Moisture content	53.6%						The product breaks into pieces
1.	0.5" Slice width	"	4.6	4.6	4.9	5.1	5.1	
2.	1.0"	"	4.5	4.7	4.8	4.9	5.0	Less breakage
3.	1.5"	"	4.7	4.9	4.9	5.1	5.1	Retain its shape
4.	2.0	"	4.9	5.0	5.0	5.1	5.1	
	Protein content	21.8%						
1.	0.5"		43.5	43.3	43.2	43.1	43.0	
2.	1.0"		43.6	43.6	43.5	43.5	43.3	
3.	1.5"		43.7	43.6	43.7	43.5	43.5	
4.	2.0"		43.8	43.7	43.7	43.7	43.7	
	Rehydration ratio							
1.	0.5"		0.89	0.89	0.88	0.70	0.6	
2.	1.0"		0.90	0.90	0.80	0.80	0.7	
3.	1.5"		0.80	0.80	0.75	0.70	0.6	
4.	2.0"		0.80	0.80	0.75	0.70	0.6	

TABLE 5. ORGANOLEPTIC EVALUATION.

S. No.	Sample	Colour	Flavour	Taste	Tex.	Shape	Overall acceptability
1.	Fresh tempeh	7.5	8.0	8.5	8.0	8.0	80.0
2.	Dehydrated tempeh	7.1	6.6	7.8	8.8	8.5	77.6

4.6, 4.8 and 4.9 to 5.0, 5.1, 5.2 and 5.2 respectively in all the four samples. This indicates that the difference in the moisture content of slices of various thickness ranges from 0.3 - 0.5%.

Protein content. Protein content in all the samples decreased from 0.1 to 0.5% showing in-significant change in total protein content during storage of dehydrated product.

Rehydration ratio. The water absorption capacity of sample No. 1 and 2 was slightly greater than that of sample No. 3 and 4 but the products break into pieces. The product of sample No. 3, 4 are acceptable in taste and texture and also retain the original shape, gradual decrease in rehydration ratio was observed during 120 days storage in all the samples.

Results of the organoleptic evaluation as given in Table 5 shows that the dehydrated product is nearly as acceptable as the fresh tempeh.

Conclusions

The present studies reveal that excellent product can be obtained if tempeh slices of 1.5", 2" width and 3" length are steamed for 5 min. on each side of the slice and dehydrated at 60° for 7 hr. The product on rehydration for two hr in tap water at room temperature after deep fat frying is as good as freshly prepared tempeh. It can be stored satisfactorily for four months at room temperature in polyethelene bags (Fig. 3). This method is more economical, the product is easy to handle and less space is required.

Fig. 3. Dehydrated tempeh.

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