USE OF SOYBEAN FLOUR IN FISH SAUSAGE PROCESSING

by

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ABSTRACT

Soybean flour was made from defatted soybean meal, a by-product of soybean oil processing. The flour processing waste was steamed, pressed, dried and ground. A preliminary experiment was directed to determine the optimum addition of soybean flour by varying the levels from 10 to 50%. An optimum level of 30% in fish sausage processing was suggested. The product was then stored at 7-10°C and evaluated organoleptically, chemically and microbiologically to determine its stability and quality changes. Fish sausage produced with no addition of soybean flour was also observed. Sensory evaluation indicated that the sausage was acceptable until the fourth day of storage.

INTRODUCTION

Defatted soybean meal (DSM), known as 'bungkil kedelai', is a by-product of soybean oil processing after the pressing step. It still contains high protein (approx. 45% db) suitable for human needs. So far, in Indonesia, the DSM is commonly used as one of materials in the production of livestock feed, but only one percent of the DSM (of about 82% DSM produced by soybean oil industries) has been used in the food industries. In other countries, primarily developed countries such as Japan, USA and Europe, the DSM is used in the formulation of various food products, e.g. meat analogues, sausage, bread, cake, noodle and macaroni (Kinsella, 1979 *cited by* Muctadi, 1989). This is due to the characteristic of soybean protein which can improve the functional properties of the products, such as emulsification, water adsorption and ability to provide good texture. In addition, the digestibility and other nutrition values of DSM are high and the price is relatively low.

Several experiments on the use of soy protein in the food processing have been reported (Cross *et al.*, 1975, Seidemen *et al.*, 1977, Andayani, 1981 and Matulis, *et al.*, 1995). However, information on the use of soy protein in sausage processing (especially fish sausage) is still limited. The research was undertaken to study the possibility of increasing the added value of DSM, as soybean flour in the fish sausage processing.

MATERIALS AND METHOD

Materials

Yellowpike congro (*Congresox talabon*) obtained from Muara Angke, Jakarta, was used as raw material in this experiment. Defatted soybean meal ('bungkil kedelai') was obtained from PT Sarpindo Soyabean Industri, Jakarta. Salt, onion, garlic, ginger, pepper, sugar, monosodium glutamate, vegetable oil and tapioca flour were the other ingredients used.

Method

Soybean flour preparation-

- Soybean flour was prepared by using the method of Koswara (1995) as follows :
- Waste of soybean oil processing was washed and steamed at 100°C for 20 minutes.
- After steaming, the product was then pressed and sundried.
- The dried product was ground and finally screened to 100 mesh. The flour was ready to be used in sausage processing.

Fish sausage processing

Processing of fish sausage was conducted using a method described by Purnomo *et al.* (1992) as follows:

- Fish was washed, filleted and minced using a meat separator.
- The minced fish was then added and mixed thoroughly with ingredients. The dough was eventually stuffed into collagen casings.
- The sausage was heated in water at 60oC for 20 min. and followed by 80oC for 40 min.
- The product was then packed in plastic bags and stored in a refrigerator at 7-10oC.

Observation

1. Raw material

Proximate composition was conducted for yellowpike congro (*C. talabon*) and the soybean flour. Fish freshness, i.e. pH and TVB content were also determined. Proximate composition including moisture, protein, fat, ash and carbohydrate content were measured using AOAC (1984) method, as follows:

- Moisture was determined using a direct heating method at 105oC
- Protein content was determined using the Kjeldahl method
- Fat content was determined using Soxhlet extraction
- Ash content was determined by incinerating a sample at 550oC
- pH was measured using a pH meter and TVB content was determined using the microdiffusion method.

2. Fish sausage produced by the addition of some levels of soybean flour

Sensory acceptability tests were carried out to determine the optimum level of soybean flour used in fish sausage processing. Five levels of soybean flour concentration were used, i.e. 10, 20, 30, 40 and 50%. A six-point hedonic scale (1: dislike very much, 6: like very much) was used to evaluate the acceptability of the products with the limit score of 3.5.

3. Fish sausage stored in a refrigerator at 7-10°C

Based on the best result, fish sausage with the optimum level of soybean flour was evaluated its quality changes during chill storage compared to control (fish sausage with no addition of soybean flour). Evaluation was carried out for proximate composition and physical properties at the initial storage and quality parameters during storage including organoleptic, chemical and microbiological quality. Physical properties observed were emulsion stability and hardness of sausage. The emulsion stability of fish sausage was determined using Webb's method (1975) and the hardness was determined using a texture analyzer having a 2 mm/sec speed. Organoleptic tests to evaluate appearance, colour, odour, flavour and texture used a 6-point hedonic scale as mentioned above. Moisture content, pH and TVB represented chemical quality while microbiological quality was represented by the total bacterial count, which was determined by the pour plate method.

RESULTS AND DISCUSSION

Raw Material

Table 1 summarizes the proximate composition of fish and soybean flour as raw material of the fish sausage. It shows that soybean flour has a high protein content (46.87% db). To indicate fish freshness, the fish was also analyzed for its pH and TVB content. The fish used had a pH value of 6.57 and a TVB content of 6.8 mgN%, indicating good quality as implied by Egan (1981) that the limit TVB content of fresh fish is 20 mgN%.

Table 1. Proximate analysis of yellowpike congro (*C. talabon*) and soybean flour as raw material of fish sausage.

Ingredient	*C. talabon*	Soybean flour
Moisture (% wb)	81.02	7.86
Ash (% db)	5.26	7.07
Protein (% db)	91.46	46.87
Fat (% db)	3.16	4.26
Carbohydrate (% db)*	0.12	41.80

* by difference

Effect of soybean flour on the acceptability of fish sausage

Soybean flour was added at 5 concentrations, i.e. 10. 20, 30, 40 and 50%. Based on panellist acceptance, as shown in Table 2, the addition of soybean flour at the level of 40 and 50% produced fish sausage with odour and taste scores which were lower than the acceptance score limit (3.5). Therefore, the maximum soybean flour added in fish sausage processing was 30%. In terms of texture, all of the sausages produced had coarse and porous texture causing low scores. This was due to the characteristic of soybean flour as a protein source with a limited carbohydrate content. To produce fish sausage with a better texture, tapioca flour was added at levels of 5 and 10%. The addition of this flour (tapioca) as a filler increased the water holding capacity and gave better texture. Observation showed that addition of 5% tapioca flour produced a solid and elastic product. The panellist scores increased from slightly dislike to like very much. During cooking, the starch was gelatinized giving a solid dough, then produced better texture and elasticity. Addition of 10% tapioca flour produced sausage with a harder texture and less elasticity decreasing the acceptance score. Further experiments on quality changes of fish sausage used 30% soybean flour and 5% tapioca flour.

Table 2. Average of hedonic scores of fish sausage added by soybean flour.

Soybean flour concentration (%)	Appearance	Colour	Odour	Taste	Texture
10	5.0	4.8	4.2	4.0	3.0
20	5.3	5.0	4.3	4.7	3.4
30	4.8	4.3	3.8	4.2	3.3
40	4.5	4.2	3.2	3.3	3.3
50	4.5	4.0	3.3	3.2	2.8

Quality of fish sausage

Fish sausage quality is shown in Table 3. It was pointed out that the use of soybean flour increased ash, fat, crude fibre and carbohydrate contents of fish sausage. While protein content of fish sausage containing soybean flour was lower than the control. This was probably due to the raw materials used, described in Table 1.

Protein content of soybean flour was much lower than the protein content of yellowpike congro (46.87% compared to 91.46%). Consequently, the addition of higher soybean flour will reduce the fish flesh content in the sausage dough, which directly had impact in decreasing protein content of the sausage.

Fat content of the sausage was in the range of 9.49 - 10.36% (db). It was relatively much lower than fat content of commercial sausage reported by Haq *et al.* (1994). The commercial sausage, particularly beef or chicken sausage had a fat content of 24.15 - 65.66% (db). Currently, most people pay more attention to their diet, especially in relation to dietary fat. Saturated fat (animal fat) is known to cause hypercholesterolemia in humans. Fish sausage, with low fat content and rich in polyunsaturated fatty acids, was found to be hypocholesterolemic. It was therefore considered to be beneficial to the health compared to beef or chicken sausage.

Crude fibre is defined as part of cell wall of plant, which is resistant to acid and base treatments. The table demonstrated that fish sausage with 30% soybean flour contained a crude fibre of 10.91%, much higher than control (1.81%). Indicating that the crude fibre content of this sausage resulted mostly from the soybean flour.

Table 3. Quality of fish sausage.

Parameters	Soybean flour percentage (%)	
	0	30
Moisture (% wb)	77.17	73.80
Ash (% db)	7.04	8.94
Protein (% db)	64.78	55.46
Fat (% db)	9.49	10.36
Carbohydrate (% db)	15.15	24.59
Crude fibre (% db)	1.81	10.91
Emulsion stability (%)	76.25	85.37
Hardness (load/mm)	79.00	65.88

In term of physical properties of fish sausage, the use of soybean flour in fish sausage processing at the level of 30% significantly increased the emulsion stability from 76.25% to 85.37%.

Koswara (1995) stated that soybean protein improved the process and stability of oil/water emulsion. Mattulis *et al.* (1995) also indicated that the cohesiveness in the sausage formulation decreased in proportion to soybean protein concentration.

Hardness, another physical characteristic of fish sausage, decreased with the addition of soybean flour, probably due to the muscle protein in the sausage formulation being substituted with soybean protein. It is known that one of the factors affecting the sausage hardness is type of protein. The protein, which has an important role in influencing product texture, is muscle protein (actine and myosin). According to Wirakartakusumah *et al.* (1992), during cooking, muscle protein denaturated and produced a harder meat texture. Cross (1975) investigated the addition of soybean flour which decreased the hardness of the muscle protein and increased the tenderness of processed minced meat.

Quality changes during chill storage

Chemical quality

Chemical quality changes of fish sausage are presented in Table 4. It is indicated that storage time did not significantly affect the moisture content. On the contrary, TVB content was influenced significantly by

storage time. TVB content increased during chill storage. This was related to degradation of protein or its derivatives during storage, producing volatile bases such as methyl and ethylsulfide, mercaptan, ammonia, amine compounds (histamine, tiramine, piperidine, putresine and cadaverine), indol and skatol (Frazier and Westhoff, 1988).

Similar to TVB content, pH was significantly affected by storage time. At the second day storage, pH increased at the initial storage and then decreased until the sixth day storage. It might be due to the breaking down of other components of the product, primarily carbohydrate, producing acid compounds, e.g. lactic acid (Fardiaz, 1992).

Table 4. Chemical quality changes of fish sausage during chill storage.

Parameter/ Soybean flour percentage	**Storage time (days)**			
	0	**2**	**4**	**6**
Moisture (% wb)				
0%	77.17	77.75	77.93	77.47
30%	73.80	74.13	73.42	74.06
TVB (mgN%)				
0%	12.4	13.2	14.6	28.8
30%	15.6	16.2	17.2	22.8
pH				
0%	6.32	6.46	6.26	5.72
30%	6.68	6.68	6.29	5.41

Microbiological quality

Total microbial load of the fish sausage as one parameter of microbiological quality was observed during chill storage. It was shown in Table 5 that total plate count of the fish sausage increased from $3.9x10^4$ - $6.4x10^4$ colonies/g at the initial storage to $1.4x10^8$ - $1.5x10^8$ colonies/g at the sixth day storage. Connel (1985) stated that the maximum TPC for processed food to be consumed safely was 10^7 - 10^8 colonies/g. The sausage, therefore, has been microbiologically acceptable up to 4 days of storage.

Organoleptic quality

Sensory evaluation results showed that the main factor affecting the panellist's acceptance was flavour and taste. At the sixth day storage, both flavour and taste scores were much lower than the limit acceptance. While for the colour, panellist did not show any rejection up to the same storage time. However, the scores mostly tended to decrease during chill storage.

Table 5. Total plate count of fish sausage during chill storage.

Soybean flour concentration	Storage time (days)			
	0	2	4	6
0%	$6.4x10^4$	$2.2x10^6$	$4.9x10^7$	$1.4x10^8$
30%	$3.9x10^4$	$1.4x10^6$	$4.7x10^7$	$1.5x10^8$

Table 6. Organoleptic quality of fish sausage during chill storage.

Parameter/ Soybean flour concentration (%)	Storage time (days)			
	0	2	4	6
Appearance				
0%	5.6	5.6	5.3	3.3
30%	5.0	5.2	4.9	3.3
Colour				
0%	5.2	5.5	5.1	3.5
30%	5.0	4.8	4.6	4.5
Flavour				
0%	4.7	5.4	3.8	2.0
30%	4.8	4.7	4.5	2.8
Taste				
0%	5.0	5.4	4.1	2.5
30%	4.9	4.8	4.6	2.5
Texture				
0%	5.0	5.5	5.0	3.7
30%	4.9	5.4	4.6	3.3

Changes in both flavour and taste scores were related to degradation process of protein during storage. Deterioration occurred because micro-organisms produced protease enzymes, breaking down the protein. The degradation of protein produced volatile compounds, e.g. indol, skatol, methylamine and ammonia which then causing undesirable flavour and taste. At the sixth day of storage, appearance score showed that the sausage did not meet the panellist's acceptance. Slime on the sausage surface was the main cause of the panellist's rejection. Slime is one of the results of bacterial spoilage in breaking down the products during deterioration process (Buckle *et al.*, 1987).

CONCLUSION

- Up to 30% soybean flour made from defatted soybean meal can be added to fish sausage.
- The shelflife of fish sausage was 4 days at chill storage.
- Addition of soybean flour in fish sausage processing increased carbohydrate, fat and crude fibre content. It also improved the emulsion stability and the tenderness of the sausage. On the other hand, the flour reduced the moisture, ash and protein content of the sausage.

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