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Production and Storage of Chinese Style Fish Sausage from Hybrid Clarias Catfish

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ABSTRACT

Chinese style fish sausage was produced from hybrid clarias catfish. The variations studied were kinds of lipids, i.e., pork fat or palm oil; amount of palm oil between 5 and 10 % (w/w) of fish meat; amount of spices between 1.2 and 1.6 % white pepper or 1.2 % white pepper plus 1.5 % mixed 5 spices powder (cinnamon, cardamom, coriander, star anise, fennel); drying time at 50°C for 28 or 48 hours. The sensory evaluation of the finished products showed that fish sausage prepared with 10 % palm oil, 1.6 % white pepper and a drying time of 28 hours received higher sensory evaluation scores than other treatments. Therefore, the products prepared under these conditions were used for shelf life study. The changes of quality of the Chinese style fish sausage whether packed and stored under the modified atmosphere of 60 % CO_2 + 40 % N_2, vacuum, or air, indicated that at 4-6°C, the shelf life of the products stored under a modified atmosphere or vacuum was at least 91 days. The shelf life of the products packed under air was only 63 days. At ambient temperatures (30-35°C), the shelf life of products stored under modified atmosphere or vacuum was 28 days, and under air it could be kept for only 8 days.

Key words: Chinese style fish sausage, hybrid clarias catfish, modified atmosphere packaging

INTRODUCTION

In Thailand, the Department of Fisheries, Ministry of Agriculture and Cooperatives has successfully crossbred male African catfish (*Clarias gariepinus*) and native female walking catfish (*C. macrocephalus*) in 1988 (Tungtongpairoj *et al.*, 1990). The hybrid clarias catfish has a high growth rate and high resistance to diseases and adverse conditions. The raising time to get 200-300 g fish is only 8-10 weeks compared with 28-30 weeks for the native walking catfish. In 2001, the total production of cultured hybrid catfish was 77,900 tons accounted for 27.8 % of the total production of cultured freshwater fish (www.fisheries.go.th). However, due to the surplus supply, the price has decreased markedly. In addition, only live fish are in demand for fresh consumption, hence the increasing cost of transportation. Chinese style sausages are very popular in Thailand, usually made from pork or chicken meat. The objectives of this study were to develop a new value added low calorie product, Chinese style fish sausage, and to study the shelf life of the product under different packaging conditions and temperatures.

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MATERIALS AND METHODS

Raw materials

Hybrid Clarias catfish (200-300 g each) were bought from a local market. The fish were beheaded, gutted, filleted, washed and packed in ice until used (within 2 hours).

Salt, sugar, soy sauce, ground pepper, mixed five spices, tapioca flour, palm oil, and pork fat were purchased from a local market.

Edible collagen casing, 2.5-cm diameter, was purchased from Vicki Co. Ltd., Bangkok, Thailand.

Processing and packaging equipment

Processing and packaging equipment and packaging material included a mixer (Kitchen Aid, model SN/FGA and SNP; USA); a hot air oven (WT-Binder model F240, Germany); a vacuum and modified atmosphere packaging machine (Henkovac 2000, Holland). Packaging material was vacuum bag from Hevel Co. Holland (polyamide/low density polyethylene (PA/LDP), 15×25 cm, 80 microns thick with CO_2, N_2, and O_2 transmission of 472, 36, 152 ml/m^2/24 h/1 atmosphere at 37°C and water vapor transmission of 4.09 g/m2/24 h at 37°C and 90% relative humidity).

Process development of Chinese style fish sausage

Hybrid clarias catfish fillets were skinned and washed 3 times with cold water to remove blood and fat. The meat was minced and mixed with other ingredients before stuffing in collagen casing, tied into a 15 cm long, and dried at 50°C.

Kind and amount of fat and spices, drying time at 50°C were varied as follows:

1. The kind of fat (pork fat or palm oil, 10 % w/w of fish meat).

2. Amount of palm oil (5 or 10% w/w of fish meat).

3. The kind and amount of spices (1.2 % pepper, 1.6 % pepper or 1.2 % pepper plus 0.5 % mixed five spices w/w of fish meat).

4. Drying time, 28 or 48 hours

Chinese style fish sausages prepared in each treatment were randomly sampled and sliced into 0.3 cm thick prior to deep-frying for 1 minutes at 170°C and subjected to sensory evaluation. The panelists comprised 8 trained judges who are staff members and graduate students of the Department of Fishery Products, Faculty of Fisheries, Kasetsart University. The test was conducted during 10.00-12.00 hours. The judges were asked to evaluate the products and scored according to the standard of Chinese-style sausage (TISI 914-1989) for color, odor, flavor, texture and overall acceptability with the highest score of each attribute at 5. The experimental design was a completely randomized design. Statistical analysis for ANOVA and Duncan new multiple range tests were carried out using SPSS statistical software.

Shelf life of Chinese style fish sausage

Chinese style fish sausages with the highest acceptability score were prepared and packed under modified atmosphere of 60 % CO_2 + 40 % N_2; vacuum or air in PA/LDP bags (200 g each) then stored at ambient temperature (30-32°C) or at 4-6°C. The chemical changes, microbial counts and sensory evaluation of the products kept at ambient temperature were conducted at 4-day intervals until the samples were rejected. Samples kept at refrigerated temperature were sampled at 7-day intervals.

The chemical analyses included proximate composition (AOAC, 1984) and 2-Thiobarbituric number (TBA) (Yu, 1967)

Microbiological analyses included total viable plate counts (TVC) (FDA, 1984); yeast and mold (APHA, 1992); *Escherichia coli*, *Salmonella*, *Staphylococcus aureus*, and *Clostridium perfringens* (AOAC, 1984).

RESULTS AND DISCUSSION

Process development of Chinese style fish sausage

Sensory evaluation scores of Chinese style fish sausages prepared are shown in Table 1-4. The proximate composition and microbiological quality are shown in Table 5 and 6, respectively.

The sensory color score of the sample prepared with palm oil was significantly higher than that with pork fat ($P \leq 0.05$) because pork fat, which was sliced into small pieces, could be seen as white spots in a finished product. However, odor, flavor, texture and overall acceptability scores were not significantly different ($P > 0.05$). Since the overall acceptability of the sample prepared with palm oil was higher, although it was not significant, in further studies, all the samples were prepared with palm oil. In addition, without pork fat, those who do not eat pork could consume the fish sausage.

The texture score of the sample with 10 % palm oil was significantly higher than that with 5 % ($P \leq 0.05$). However, the other quality attributes such as color, odor, and flavor were not significantly different ($P > 0.05$). The standard of Chinese style sausage (TISI 914-1989) has limited the fat content to be less than 45 %. The finished products prepared with 10 % palm oil contained only 10.6 % fat. Therefore, the fat content of the prepared Chinese style fish sausage was very low compared with commercial pork or chicken sausages.

The sensory evaluation scores of samples varied by spices indicated that color, flavor and overall acceptability of samples prepared with 1.2 or 1.6 % pepper were significantly higher than that with 1.2 % pepper plus 0.5 % mixed 5 spices. This was due to the color and odor of mixed five spices

Table 1 Sensory evaluation scores of Chinese style fish sausages prepared with pork fat or palm oil.

Sensory attributes	Average sensory evaluation scores	
	Pork fat	Palm oil
Color	2.9 b	3.6 a
Odor	3.3 a	3.6 a
Taste	3.9 a	4.0 a
Texture	2.7 a	3.2 a
Overall acceptability	2.8 a	3.0 a

Values in the same row followed by different letters are significantly different ($P \leq 0.05$) by DMRT.

Table 2 Sensory evaluation scores of Chinese style fish sausages prepared with 5 or10 % palm oil.

Sensory attributes	Average sensory evaluation scores	
	5 % palm oil	10 % palm oil
Color	3.7 a	3.9 a
Odor	3.8 a	4.2 a
Taste	3.7 a	3.7 a
Texture	3.4 b	4.5 a
Overall acceptability	3.1 b	4.0 a

Values in the same row followed by different letters are significantly different ($P \leq 0.05$) by DMRT.

which were dark brown and strong odor. However, the sensory scores for the taste and texture of all samples were not significantly different (P>0.05).

The sensory evaluation scores for texture and overall acceptability of the sample dried at 50°C for 28 hours were higher than that dried for 48 hours (P≤0.05). In general, the drying time for Chinese style pork sausage was reported at 48 hours, but the texture of fish sausage that contained lower fat content was hard and tough if dried for 48 hours.

Table 3 Sensory evaluation scores of Chinese style fish sausages prepared with different spices.

Sensory attributes	Average sensory evaluation scores		
	1.2 % pepper	1.6 % pepper	1.2 % pepper + 0.5 % mixed five spices
Color	4.3 a	4.3 a	3.5 b
Odor	4.3 a	4.3 a	3.6 b
Taste	3.7 a	3.8 a	3.7 a
Texture	4.0 a	4.1 a	3.8 a
Overall acceptability	4.0 a	4.3 a	3.2 b

Values in the same row followed by different letters are significantly different (P ≤ 0.05) by DMRT.

Table 4 Sensory evaluation scores of Chinese style fish sausages drying at 50°C for 28 or 48 hours.

Sensory attributes	Average sensory evaluation scores	
	Drying time 28 h	Drying time 48 h
Color	3.5 a	3.4 a
Odor	3.6 a	3.4 a
Taste	3.7 a	3.5 a
Texture	4.2 a	3.6 b
Overall acceptability	4.2 a	3.5 b

Values in the same row followed by different letters are significantly different (P ≤ 0.05) by DMRT.

Table 5 Proximate composition and water activity of fish sausages prepared with 10 % palm oil, 1.6 % pepper and drying at 50°C for 28 hours.

Moisture (%)	38.60
Protein (%)	15.59
Fat (%)	10.62
Ash (%)	3.36
Carbohydrate (%)	31.83
Water activity	0.807

Values are average of 3 determinations.

Table 6 Microbiological quality of fish sausages prepared with 10% palm oil, 1.6 % pepper and dried for 28 hours compared with TISI microbiological standard of Chinese style sausage.

Microbiological quality	Fish sausages	TISI standard
Total bacterial count CFU/g	3.5×10^5	1.0×10^6
Mold CFU/g	ND	< 100
E. coli	< 3 MPN	< 3 MPN
Salmonella sp	ND	ND in 25 g
Staphylococcus aureus	ND	ND in 0.1 g
Clostridium perfringens	ND	ND in 0.01 g

ND, not detected.

According to the TISI standard on microbiological quality, it was found that the prepared samples met the microbiological standard. The total viable counts were lower and no pathogenic bacteria were detected.

In conclusion, from the sensory evaluation scores, the most acceptable recipe of Chinese style fish sausage was as follows:

- 60.5 % hybrid *clarias* catfish meat
- 1.8 % salt
- 18.0 % sugar
- 0.7 % soy sauce
- 1.0 % ground pepper
- 6.0 % tapioca flour
- 6.0 % palm oil
- 6.0 % water

Shelf life of Chinese style fish sausage
At ambient temperature (30-32°C)

Moisture content, total bacterial, yeast and mold counts and overall acceptability scores of Chinese style fish sausage stored under different conditions at ambient temperature are shown in Figure 1-4.

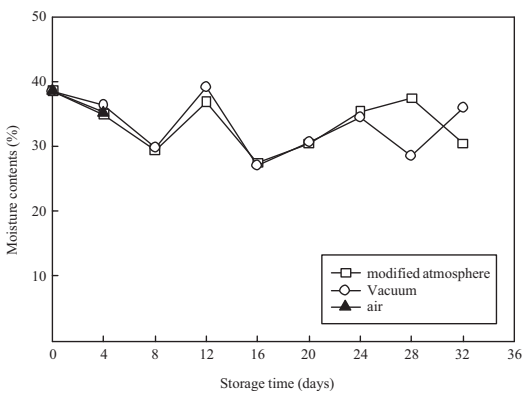

Figure 1 Moisture contents of Chinese style fish sausage stored under modified atmosphere, vacuum and air packaging at ambient temperature.

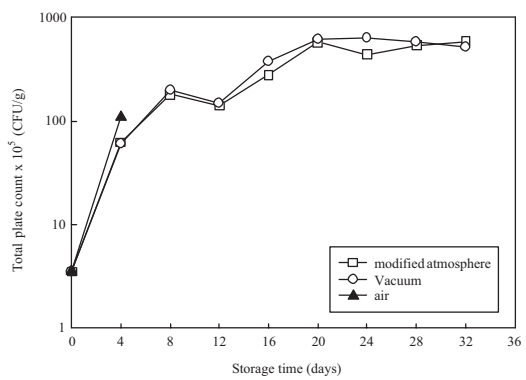

Figure 2 Total plate counts of Chinese style fish sausage stored under modified atmosphere, vacuum and air packaging at ambient temperature.

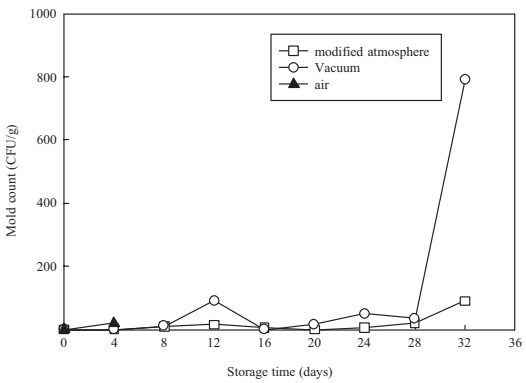

Figure 3 Mold counts of Chinese style fish sausage stored under modified atmosphere, vacuum and air packaging at ambient temperature.

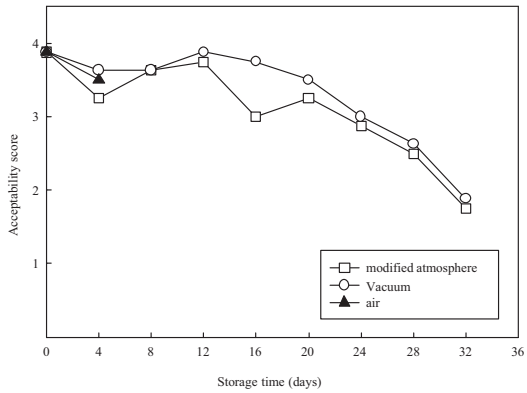

Figure 4 Overall acceptability scores of Chinese style fish sausage stored under modified atmosphere, vacuum and air packaging at ambient temperature.

During storage, the moisture contents of the samples ranged from 39.25 – 27.05 %. The slight decrease in moisture content was due to the water vapor transmission of the packaging material. After 8-day storage, there was mold growth on the surface of the samples, which was due to high moisture content. TISI standard for Chinese style sausage has limited the moisture content at less than 30 %; therefore, the prepared samples did not meet the standard on moisture content. Besides, the fish sausages were prepared without any food preservative such as nitrite or nitrate.

For TBA values measurement, it was found that the color developed was yellow not red color as it should be from the reaction between malonaldehyde and 2-thiobarbituric acid. The yellow color might be from soy sauce. However, sensory evaluation scores indicated that during storage there was no development of rancidity or any other off flavor.

The initial microbial counts in the samples were rather high, which might be due to contamination during processing and packing. On the first day, the average total bacterial count was 3.5×10^5 CFU/g. The number increased rapidly. After 8 days, there was mold growth on the sample surface, therefore they were discarded. Comparison of different storage conditions indicated that under air, the total bacterial counts were the highest, whilst under modified atmosphere and vacuum, the increases in bacteria were similar (Figure 2). Although Farber (1991) reported the inhibition effect of CO_2 on bacteria, especially Gram negative aerobes, the experiment showed that the effectiveness of CO_2 was reduced at higher temperatures. Therefore, it could be concluded that at ambient temperature, modified atmosphere packaging was able to slightly prolong the shelf life of the products. In addition, the high initial number of contaminated bacteria reduced the inhibitory effect of modified atmospheric package.

At refrigerated temperature (4-6°C)

Moisture content, total bacterial, yeast and mold counts and overall acceptability score of Chinese style fish sausages stored under different conditions at refrigerated temperatures are shown in Figure 5-8.

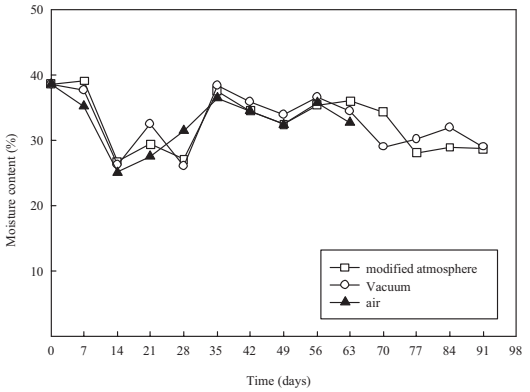

Figure 5 Moisture contents of Chinese style fish sausage stored under modified atmosphere, vacuum and air packaging at 4-6°C.

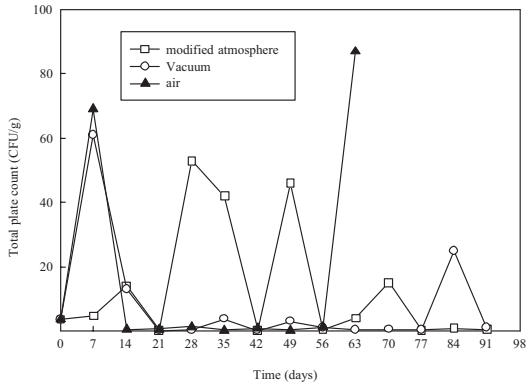

Figure 6 Total plate counts of Chinese style fish sausage stored under modified atmosphere, vacuum and air packaging at 4-6°C.

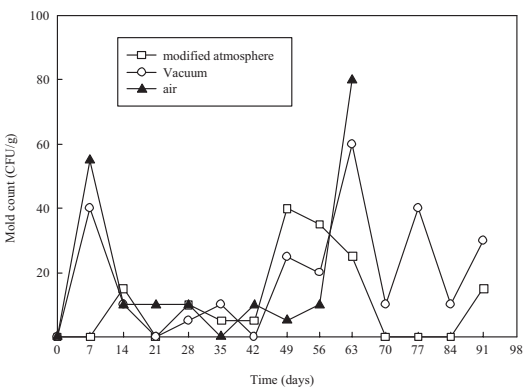

Figure 7 Mold counts of Chinese style fish sausage stored under modified atmosphere, vacuum and air packaging at 4-6°C.

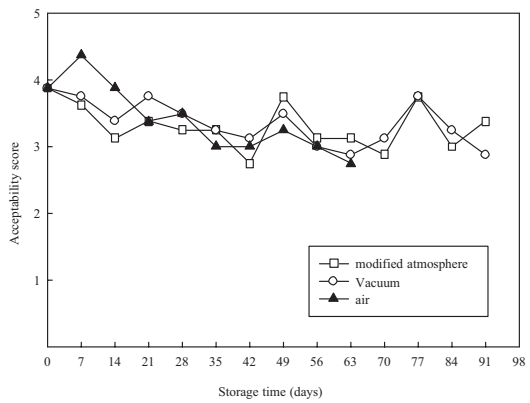

Figure 8 Overall acceptability scores of Chinese style fish sausage stored under modified atmosphere, vacuum and air packaging at 4-6°C.

The moisture contents of the samples throughout the period of 91 days ranged from 39.15 – 26.15 %. At the end of storage, moisture content had moderately reduced from the initial content. It was found that packaging conditions had no effect on moisture content ($P>0.05$). However, at different storage times, moisture contents were slightly different, which might be due to the manual stuffing of the sausage that caused a small variation in diameter of the finished products. This affected the initial moisture content after drying.

TBA determination in samples stored at 4-6°C was the same as at ambient temperature, and sensory evaluation indicated that there was no development of rancidity during storage tests.

Total bacterial counts of samples stored under modified atmosphere or vacuum were close

to the initial number, but for samples packed under air, there was a trend to increase. Newton *et al.* (1977) as well as Lannelongue *et al.* (1982) also reported the effect of modified atmosphere at low temperature on spoilage bacteria in food. Bank *et al.* (1980) preserved fresh fish by storing under the atmosphere of 15 lb/in^2 CO_2 at 4°C and reported the reduction of *Pseudomonas* and *Alteromonas* and the increase in number of *Lactobacillus*, which produced lactic acid and lowered the pH, hence inhibited other microorganisms. Furthermore, effectiveness of CO_2 was increased at lower temperature due to the increase in solubility of gas in the liquid part of food (Daniels *et al*., 1985).

Yeast and mold counts of all samples changed slightly and were lower than TISI standard for Chinese style sausage, which set the mold counts to be less than 100 CFU/g. Under modified atmosphere, yeast and mold counts were the lowest (0-40 CFU/g) whilst under vacuum and air, the counts were 0-60, and 0-80 CFU/g, respectively. Shin and Marth (1973) reported the effect of modified atmosphere or nitrogen packing on growth and toxin production of molds.

Sensory evaluation indicated that packaging conditions had no effect on acceptability scores, but longer storage time reduced the acceptability scores of all samples regardless of packaging conditions. However, after 91 days all samples were still acceptable, but the samples stored under air got the lowest acceptability scores. In addition, the judges also commented that texture of the products was less homogenous as the storage time increased.

CONCLUSION

It was found that hybrid clarias catfish was a suitable raw material for the production of Chinese style fish sausage. Palm oil could replace pork fat to make the Halal food for the Moslem. Modified atmosphere packaging under 60 % CO_2 + 40 % N_2 could extend shelf life of finished product to at least 91 days at 4-6°C or 28 days at ambient temperature.

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