J. KOREAN SOC. FOOD NEUT.
16(1) 36~41 (1987)

Induction Period and Oxidative Rancidity of Refrigerated Fish Meat

Joe, Sang-June Kim Dong-Yun*

Chosun University Technical Jr. College
** Chonnam Nat. Univ., Agricultural College*
(Received February, 12. 1987)

凍結魚肉의 誘導期와 酸化

曺 湘 俊·金 銅 淵

朝鮮大 工業專門大學 食品工業科
* 全南大 農科大學 食品加工科
(1987년 2월 12일 접수)

要 約

우리나라의 漁獲物에서 約 50%가 凍結貯藏되고 赤色魚類인 고등어와 白色魚類인 참조기는 沿岸에서 漁獲되는 代表的인 凍結貯藏魚種이다. 凍結貯藏中의 變質의 重要한 因子인 脂肪酸化에 對한 基礎的인 知識을 얻기 爲하여 木浦水協 共販場에서 購入한 鮮魚를 −30℃에서 凍結하고 film包藏하여 −18℃로 貯藏하며 實驗하였다.

新鮮魚肉의 誘導期는 約 20日이고 加熱魚肉은 約 60日 이었으며 酸化의 程度는 過酸化物價와 TBA價로 比較하면 加熱肉이 新鮮肉의 約 切半을 나타냈으며 또한 고등어肉이 참조기肉의 값의 約 2倍로 魚種에 따라 差異가 있었다. 凍結貯藏에서 溫度에 따른 酸化程度는 −5℃에서 酸化抑制作用이 最大이었고 이 온도를 벗어나면 酸化가 促進되었다.

Introduction

Mackerel and yellow corvenia on Korea are the major species of fish harvested. The productive amount of the fishery products of Korea were about 100,000 M/T of mackerel and 50,000 M/T of yellow corvenia in 1984. The half amount of the fishery products in Korea should be refrigerated for cold storages to keep the freshness and prevent the deteriorations of lipid autoxidation of fish meats. Lipid oxidation of fishery products has been considered a matter of great importance among all the deteriorations during the refrigerated storages.

In the processing and the cold storage of fish, factors which may affect the rate of oxidation include chemical composition, handling procedure, the conditions of storage and external factors such as heat, acid, alkali and salt. Data relating these factors to the oxidative reaction would be helpful in determining more effective methods of controlling rancidity stored temperature.

The oxidation of lipid was known that the classical mechanism is via free radicals reacted wtih oxygen in the progress of induction, propagation and final period. Ali et al,[1] reported that the oxidative rancidity in refrig-

erated storages takes place with off-flavor, insoluble lipid-protein complexes and so on although the fish was preserved in deep frozen states. Mendenhall[2] also had reported the incidence and the rates of oxidative rancidity[3] in the muscle tissue of several fish species from the Gulf of Mexico such as mullet, mackerel and red drum. But we have no reported the incidence and the rates of oxidative rancidity in the muscle tissue on the major fish refrigerated after harvesting.

The purpose of this study was to determine the induction period that was observed by weight gain technique and peroxide values and to mearure the extent of oxidative rancidity by peroxide values and thiobarbituric acid values from the trends of lipid oxidative patterns in the refrigerated storages of the fresh and cooked meets of mackerel and yellow corvenia.

The induction period is one of the very important factors to preserve the freshness in the fish processing procedure on these samples. As the half products of processed sea foods were the freezing products in recent fish processing of Korea, we need a rapid and simple method to determine the induction period of the lipid oxidation.

The effective temperature on the lipid rancidity was also measureed by the chemical values such as peroxide and thiobarbituric acid to prevent the ranciditive deteriorations from the refrigerated fish meats that are in the autoxidation during freezing storage at 2℃, −5℃ and-18℃.

Although this study was a little progress to control the deterioration of fish, additional information must be needed to accurately establish the effect of oxidative rancidity on the spoilage patterns of fresh and cooked fish.

Materials and Methods

1. Preparation of samples

Mackerel, *Scomber japonicus* (body length, 35*cm*), and Yellow corvenia, *Pseudosciaena manchuria*(body length, 34*cm*), were caught from the West sea and purchased at Mokpo Fish Market on july of 1985 as very fresh. Fresh mackerel and yellow corvenia were eviscerated, dressed, and cooked in boiling water for 8 minutes that come from the result of Ali et al., and packed with polyethylene film(20×50×0.05*cm*), frozen at-30℃ and stored at-18℃ and then raw dressed samples were frozen and stored at same temperatures in order to compare with raw and cooked samples.

In the decision of the best temperature on the prevention of the oxidative rancidity, each sample had the same preserved temperature all through the storage times such as 2℃, ~5℃ atd-18℃.

2. Experimental methods

1) Chemical components

Moisture, ash, crude protein and lipid[4] were determined by general methods and the total sugar were measured by somogyi's method.

2) Induction period

This was measured by the weight gaining method at 30℃ as 0.5 percent increasing times on the 5 gram oil of each sample, which was the total lipid extracted from two samples with methyl alcohol: chloroform(1: 1) solution for 24 hours and lipid extracted with soxhlet method.

3) Peroxide value

This was determined by iodine titration method and and expressed the result as equivalent *mg* amount of 1*kg* sample.

4) Thiobarbituric acid value

This value was determined by Tarladgi's distillation procecure at 535nm wavelength of spectrometer and the value was the optical density in this method.

Table 1. Approximate composition of yellow corvenia and mackerel

fish	\component	moisture	protein	lipid	sugar	ash
yellow corvenia	reference*	81.7	18.3	0.8	0	1.3
	fresh	76.5	18.5	2.5	0.1	1.5
	cooked	72.9	18.0	0.9	—	1.9
mackerel	reference*	76.0	18.0	4.0	0.7	1.3
	fresh	71.5	18.1	7.5	0.5	2.1
	cooked	70.1	17.2	4.9	0.5	1.9

Results and Discussion

1. Changes of chemical components

The content of moisture, crude protein, lipid, sugar and ash were listed in table 1.

The reference* came from the data of nutritional textbook.[5] Table 1. showed us that the experimental results of the fresh, the cooked and reference. Between the fresh and the cooked fish meat, the moisture component was a little lower values than the average amounts and lipid had much high values. There were no saccharides in yellow corvenia and a little those in mackerel as almost same as general value.

Few changes of chemical components were detected in the view point of general composition except moisture and lipid. The amount of moisture was decreased in accordance with slightly decreased lipid. But ash content had a little amount increasing in the samples. It was presumed that the cooking made the samples to be decreased the amount of water and lipid.

In the cooking times, table 1, showed us that protein and moisture content was decreased in a little amount, and that lipid amount was decreased very much. But the ash content had a trace increasing.

2. Induction period

The free radical mechanisms[6] of lipid oxidation are well established such as induction, propagation and final period as well as other component's oxidation. Waissbluth et al.[7] reported on the relationship between the rate of oxygen absorption and the rate of consumption of reactive lipids in fish muscle and then referred that the weight of lipid was increased.

Therefore, the author may be measured the gained weight in the oxidative rancidity for 4 months at refrigerated storages in order to determine the induction period as shown in Fig. 1.

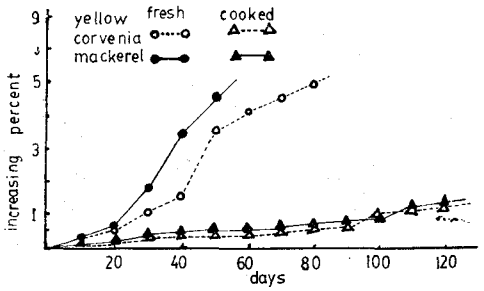

Fig. 1. Weight gaining percent of 5g oil from mackerel and yellow corvenia.

Fig, 1. showed the cooked meats had a little wieght gaining until 60 days at the refrigerated storage of-18℃ and the fresh meats had a very sharply increasing after 20 days. As the induction period was defined that the times of 0.5% weight increasing of the fish oil, the induction period of the fresh meat had 20 eays and that of the cooked meat had 60 days which was a very high weight gaining in spite of the average induction period of rancidity, 10 hours

at 50℃ in other thesis. That's why the temperature was very lower as-18℃ and polyethylene film packaging.

From the Fig. 1., it should be referred that the different induction periods between fresh and cooked meat were caused by the different amounts of active biochemical substances as prooxidants and decreasing radicals of the muscle tissue from cooking. Young and Karel[8] reported that inorganic iron and copper related to be strong pro-oxidative catalysts in lipid oxidation, particularly in mackerel meat lipids such as various biochemical substances, amino acids, pigments and fish tissues and then shown to catalyze the lipid oxidative reaction, alone or in association with certain trace metals.

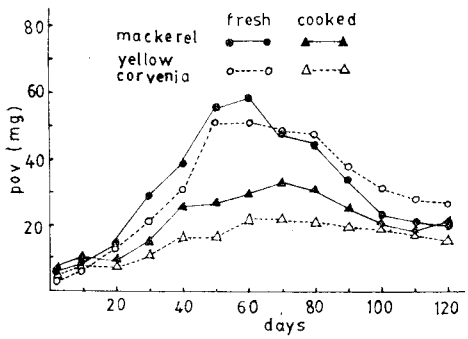

Fig. 2. Changes of peroxide values of the meats of mackerel and yellow corvenia in refrigerated storages (−18℃).

In order to reinforce the determination of induction period. we had an another chemical experiment as the peroxide value of the refrigerated fish meats as shown in figure 2.

We can make an induction period in the point of 20∼40*mg* equivalent amount[6] of increasing values in the case of animal muscle.

Figure 2. showed us that the induction period was about 25 days on the raw dresssed fish and about 60 days on the cooked dressed fish. Therefore, we should determine the induction perion was about 20 days in the fresh meats and about 60 day in the cooked meats.

3. Oxidative rancidity

The rates of oxidative reaction were found to be dependent upon the class of compounds being oxicized. These oxidized products are many kinds of peroxides, hydroperoxides, aldehydes and carbonyls. Peroxides and malonaldehydes of them are very effective compounds to determind the degree of oxidative rancidity.

Figure 2. was shown that the peroxide value would be used to measure the oxidative rancidity as shown in the study of Haki et al.[9] The peroxide value of mackerel and yellow cervenia sharply increased after 20 days at-18℃, and mackerel had a little more peroxide value than that of yellow corvenia.

But they were to get similar values in the cooked and fresh samples in the storage time passed. Figure 2. was also indicated that the highest period of peroxide value was about 60 days storages, which was the times of oxidative rancidity took place.

In spite of this result, Lee at al.[10] reported that the peroxide value of fermented sardine was the highest after 31 days and decreased more or less after then in partial freezing. Between two samples, there quite different peroxide values as shown in figure 2. such that fresh meat had double amount at the highest peroxide value. Suh at al.[11] explained the reason why the cooked meat which was half value of that of fresh meat was suppressed by heating.

TBA value determination[12] was a good background to be reassured the peroxide value in the oxidative rancidity of the reprigerated storage and study the effects of different refrigerated storage temperatures in the lipid oxidation.

Figure 3. and 4. were shown by TBA values which were measured at 535nm wavelength that made the most effective absorption. from figure 3. and 4., TBA values were rapidly increased

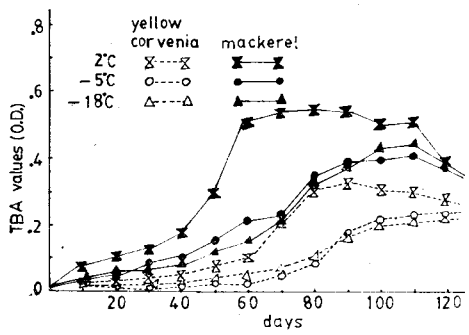

Fig. 3. Changes of TBA values in the fresh meats of mackerel and yellow corvenia at several storage temperatures.

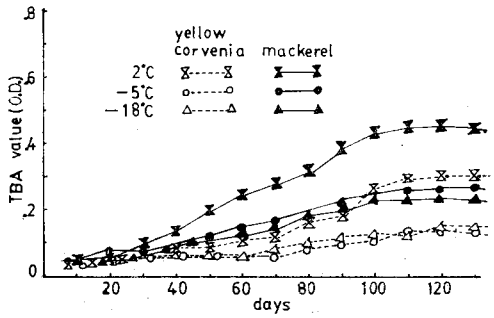

Fig. 4. Changs of TBA values in the cooked meats mackerel and yellow corvenia at several storags temperatures.

after 60 days and had between about 0.1 and 0.1 values, which were very lower in the contrast with the results of Margarett et al.,[13] that were measured in cold storage of sark and mackerel meat such that the TBA value was about 5 for 5 day storages. Tay et al.[14] also reported that TBA value of homogenated pork added with iron metal as very low values.

Those two studies gave us an reasonable explanation, which were the lower TBA values come from the depression of oxidation because of refrigerated storage and polyethylene film packaging. Figure 3. showed us that oxidative rancidity had much effective prevention in the conditions of freezing temperature of - 18℃.

The trends of lipid oxidation in figure 4. had a period of 60 days in the cooked fish samples at 2℃ and more longer days than 120 days in the cooked meats of mackerel and yellow corvenia at-5℃ and-18℃. In the study of Husunu et al.,[15] TBA value of the packaged beef storage had sharply increased after 45 days, which was very similar pattern with the result of this study. But Tellefson et al[16] also reported that the malonaldehyde amount of turkey muscle had the same TBA value during the storage of fresh and refrigerated muscle whether it was added with additives or not until 3 weeks.

Figure 3. and 4. were indicated that the effects of low temperature had a little TBA value and more effectiveness at-5℃ among the different temperatures. Lee et al.[10] reported that TBA value of polyethylene packaged cooked mackerel had no difference during 6 month storages at-3℃ and-5℃, which was different in compared with this study. But we need to study more about the lipid oxidation in cold storages to prevent the deterioration.

Abstract

In the refrigerated storages of fishery products, the lipid oxidation of the meats had been the major deterioration factor. For the effective utilization of mackerel, *Scomber japonicus*, and yellow corvenia, *Pseudosciaena manchuria*, which are major costal fish in Korea, and were studied about oxidative rancidity during the refrigerated storage at-18℃ and the effect of different temperatures upon the cooked meat. We detected the results followed.

1. The induction period of refrigerated storages had 20 days for fresh meat and 60 days for cooked meat.

2. Peroxide and TBA value of cooked meats had half amount values in the comparison with those of fresh meats.

3. Values of mackerel had double amount

than those of yellow corvenia in peroxide and TBA value as if the different values come from different fish species.

4. The rancidative degree of the different temperatures on the samples had the least amount at-5℃ among several kinds of storage temperatures.

References

1. Ali Khayat and Don Schwall: Lipid Oxidation. *Food Tech.*, *Vol.* **37**, No. 7, 130~140 (1983).
2. Mendenhall U.T.: Oxidative Rancidity in Raw Fish Fillets harvested from the Gulf of Mexico. *J. of Food Sci.*, **37**, 547~549 (1972).
3) Igene, J.O., Pearson, A.M., Merkel, R.A., and Coleman, T.H.: Effect of Frozen Storage Time, Cooking and Holding Temperature upon Extractable Lipids and TBA Values of Beef and Chicken. *J. Anim. Sci.*, **49**, 701 (1979).
4. A.O.A.C.: American Official Association of Chemists, 13th ed. Assoc. of Office, Agr. Chemists, Washington D.C. 440 (1980)
5. Chai Rae-suk: Food analysis data, Introduction of food nutrition, Jiphyunsa, index (1975).
6. Kim Dong Hoon: Food chemistry, Chapter 14, Lancidity of Lipid, Tamgudang Co., 469~471 (1968).
7. Waissbluth M.D., Buzman L., and Tlacho F.P.: Oxidation of Lipids in Fish Meal. *J. Am. Oil Chem. Soc.*, **48**. 420 (1971).
8. Young S.H. and Karel N.: Reaction of Histidine with metal linoleate: Characterization of the Histidine degradation products. *J. Am. Oil Chem. Soc.* **55**, 352 (1978).
9. Haki Kazufumi and Akiya Toshimi: Food Oxidation and its Prevention. Chapter 2. Measurement of Oxidation, Korinzensho co., 49~58 (1971).
10. Lee Eung-ho, Jeong-gyun Kim, Jae-Ho Ha, Kwang-soo Oh and Yong-jun Cha: Partial Freezing as a Means of Keeping Quality of Sea Foods. *J, of Kor. Soc. of Fd. and Nut.*, **12**, 2, 63~65 (1983).
11. Suh Jae-soo, Kang-ho Lee and Jin-ho Jo: Quality Change in precooked sardineduring Frozen Storage. *Bull. Korean Fish. Soc.* **16**, 2, 117~124 (1983).
12. Greene B.E. and T.H. Cumuze: Relationships between TBA numbers and inexperienced panelists assessments of oxidized flavor in cooked beef. *J. of Fd. Sci.* **47**, 1, 52~54 (1982).
13. Margarette T. Jounathan, Jual K. Oon and Rokiah Mohd Yusof: Control of Heat Induced Oxidative Rancidity in Refrigerated Shark and Macherel. *J. of Food Sci.*, **48**, 1, 176~178 (1983).
14. Tay H.C., E.D. Aberle and M.D. Judge: Iron catalyzed oxidative rancidity in prerigor ground Pork. *J. of Food Sci.*, **48**, 4, 1328~1330 (1983).
15. Husunu Y. Gokalp, Herbert W. Ockerman, Rodney F. Plimpton and W. James Harper: Fatty acids of Neutral and Phospholipids, Rancidity Scores and TBA Values influenced by packazing. *J. of Food Sci.*, **48**, 3, 82~98 (1983).
16. Tellefson C. Susan, Jane A. Bowers, Cecelia Marshall and Arthur D. Dayton: Aroma, Color and Lipid Oxidation of Turkey Muscle Emulsions. *J. of Food Sci.*, *Vol.* **47**, 2, 393~396 (1982).