

## TA no. 88

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### Evaluation the Oxidation Nature of the Fat and the Processed Food

— Evaluate the safety of foods by Oxidative Induction Time measurement using TG/DTA—

#### 1. Introduction

Recently people become more aware of the safety of the food after the several problems and accidents of the mislabeled material of food. Food safety is evaluated by various analyses. Especially the fat in the food gets oxidized and deteriorate rapidly. The fat can be changed to harmful ingredient as well as the scent, color, and taste are changed. It has code and standard such as Food Sanitation law. Degradation level is evaluated by the analysis of acid value and peroxide value; however, it requires time and procedures such as the extract of fat. For easier solution, TG/DTA method is introduced which can measure the small amount of sample and without extract.

In this brief, TG/DTA are used to evaluate the oxidation nature of the fat and the processed food by measuring Oxidative Induction Time measurements.

#### 2. Measurement

Fat such as soybean oil, sesame oil, and palm oil and fat acid such as stearic acid (saturated fatty acid), oleic acid (monounsaturated fatty acid), Inoleic acid (di-unsaturated fatty acid), and linolenic acid (tri-unsaturated fatty acid). Processed food such as commercially-available processed soybean product, sesame, snack food, and instant noodle are also

measured. Processed food is first milled for 30 seconds without extract of fat. Then the sample which is stored at room temperature is picked up periodically and measured.

The measurements are performed using the TG/DTA7200 Thermo Gravimetry Differential Thermal Analyzers. A 2mg sample of fat, 15mg of fatty acid and processed food are weighed in an aluminum open sample pan and heated from room temperature to 150°C at a rate of 10°C/min in a nitrogen atmosphere and then stayed isothermal in a oxygen atmosphere. Then it is measured by time of exothermic peak occurred by oxidation (Figure 1).

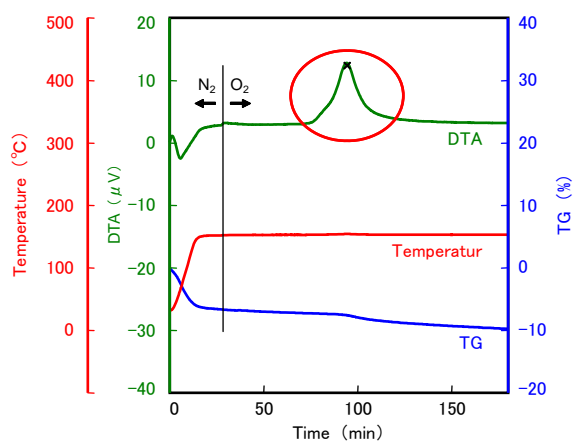


Figure 1 TG/DTA measurement results of oxidative induction time

### 3. Results

#### 3-1 TG/DTA measurements of fat

Figure 2 shows TG/DTA measurement results of 3 kinds of fat. For soybean oil and sesame oil, it shows exothermic peak in around 20 minutes after introduce oxygen. It is earlier than that of palm oil which takes 49 minutes. Also, it has a significant peak. At the same time TG signal shows weight gain and loss.

Table 1 shows constituent fat and oil of each oil. Compared with palm oil contains much saturated fatty acid, soybean oil and sesame oil contains much unsaturated fatty acid which is high reactive to oxidation, they likely to have a tendency to have earlier exothermic heat of oxidation.

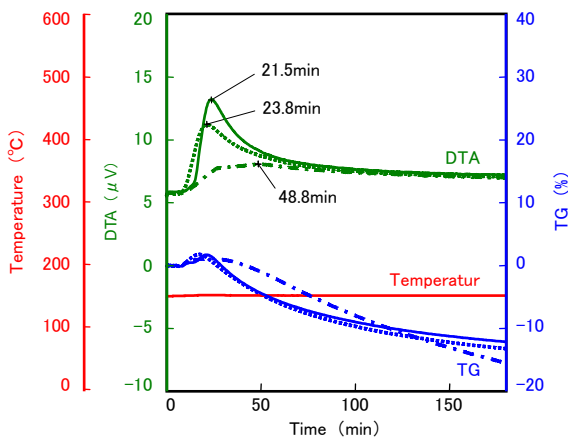


Figure 2 Comparison of DTA and TG curves of fat and oil

- soybean oil
- ..... sesame oil
- . - . - . palm oil

Table 1 Main constituent fat and oil

Sample	palmitic acid*	oleic acid	Inoleic acid
soybean oil	—	23.5%	53.5%
sesame oil	—	39.2%	45.8%
palm oil	43.1%	40.7%	—

\* : saturated fatty acid

#### 3-2 TG/DTA measurements of fatty acid

Figure 3 shows TG/DTA measurement results of fatty acid. Carbon number of these 4 kinds of fatty acid is 18. Stearic acid, oleic acid, Inoleic acid, and

linolenic acid have double bond number in ascending order. It has a tendency that exothermic peak top of linolenic acid appears earlier than any others. More unsaturated bonds it has, the earlier the peak top appears. It shows the cause of oxygen to unstable double bond. Fat and oil which chief ingredient is unsaturated fatty acid is easy to oxidize.

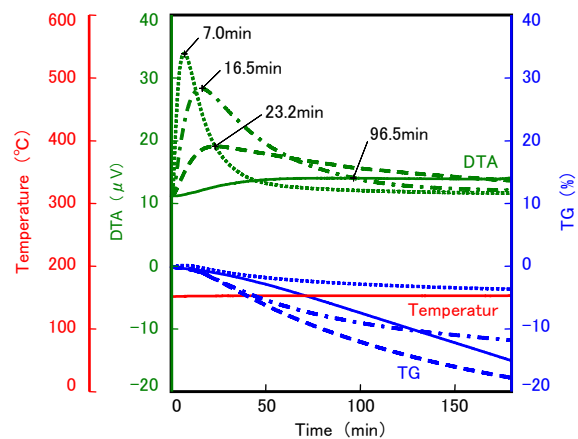


Figure 3 Comparison of DTA and TG curves of fatty acid

- stearic acid
- - - oleic acid
- . - . Inoleic acid
- ..... linolenic acid

#### 3-3 TG/DTA of processed food

Figure 4 to 7 shows TG/DTA measurement results of each sample. For all results, the time when exothermic peak appears become earlier as the number of storage days become longer (Figure 8). Fat and oil is oxidized as days pass and become easy to be decomposed.

Also, compared with the oxidization nature of only fat and oil, processed food which includes other than fat and oil shows its peak top appears late. The oxidization peak of soybean appears later than that of sesame. Snack food does instant noodle. It is likely to show the difference in oxidization stability effect caused by additive such as antioxidant. This result indicates that TG/DTA is useful in oxidization stability measurement of fat and oil even the processed food.

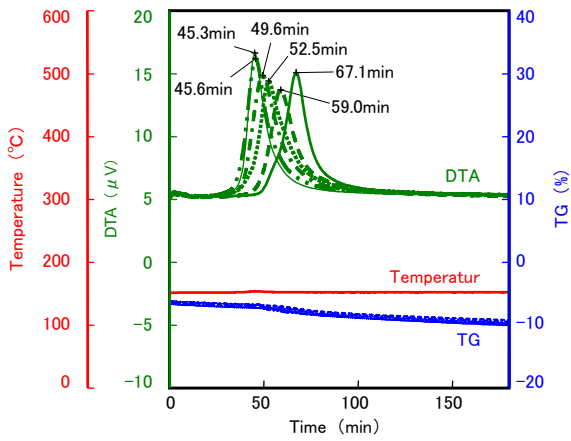


Figure 4 TG/DTA measurement results of soybean oil

- 0 day
- - - - after 7 days
- ..... after 14 days
- · - · after 21 days
- · · - after 28 days
- after 56 days

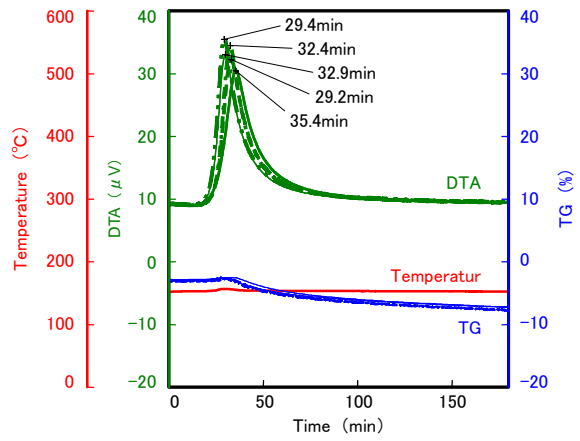


Figure 5 TG/DTA measurement results of sesame oil

- 0 day
- - - - after 7 days
- · - · after 21 days
- · · - after 28 days
- after 56 days

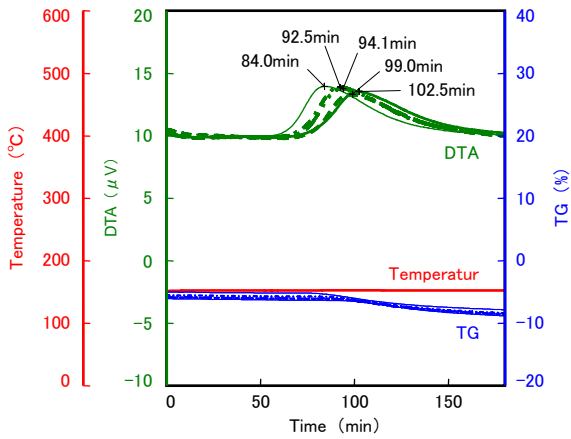


Figure 6 TG/DTA measurement results of snack food

- 0 day
- - - - after 7 days
- · - · after 21 days
- · · - after 28 days
- after 56 days

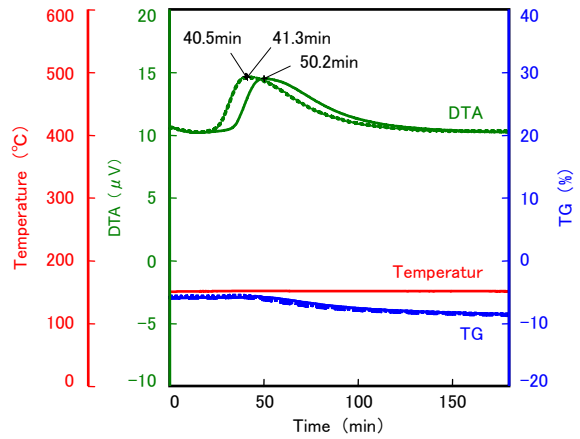


Figure 7 TG/DTA measurement results of instant noodle

- 0 day
- - - - after 7 days
- ..... after 14 days

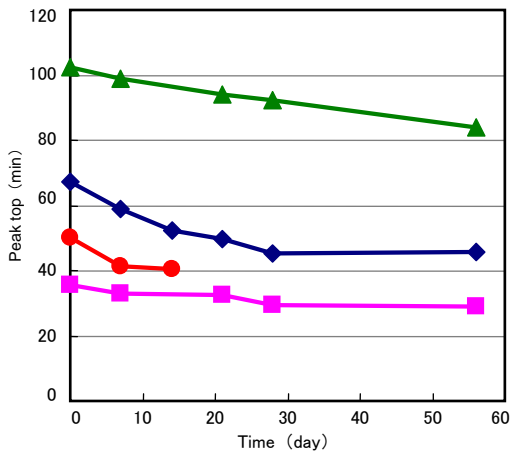


Figure 7 Relationship between the number of days elapsed and oxidation peak

- ◆ soybean
- sesame
- ▲ snack food
- instant noodle

#### 4. Summary

In this brief, fat and oil, and fatty acid which constitute fat and oil are measured by Oxidative Induction Time measurement using TG/DTA.

As a result the difference in oxidization nature can be measured from the quantity of fat and oil which is composed of unsaturated fatty acid.

In case of processed food it is very easy to handle as it can be measured without extraction of fat and oil. Also in case of the processed food which contains multiple components such as additives, the difference in oxidization nature can be measured.

#### Acknowledgement

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#### References

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- 2) Yoshikazu Nishiyama, Yuichi Kasai and Yutaka Ichimura, *The 44<sup>th</sup> Japanese Conference on Calorimetry and Thermal Analysis*, 162 (2008)