Evaluation of antioxidant efficiency in animal fat using a modified Rancimat test method

Arnaud J.N., Lechat H., Lacoste F.
ITERG, French Institute for Fats & Oils - f.lacoste@iterg.com

Rancimat is an automated apparatus which is dedicated to the determination of oxidative stability of fats and oils at high temperature according to AOCS Cd12b or ISO 6886 standards. In order to reduce the duration of the test for animal fat additivated with synthetic antioxidants, both the effect of the temperature variation and the addition of pro-oxidant substances, were studied. Addition in the oxidation cell of copper reduces dramatically the Rancimat induction period. New conditions of Rancimat test were developed using copper powder in the test sample and an aging temperature of 85°C. The RIP obtained still allows to discriminate the antioxidant efficiency in a reduced time.

Introduction

Animal fats do not content any natural antioxidant so in order to increase their stability towards oxidation, synthetic antioxidants have to be added. One of the easiest way to compare the efficiency of the addition of synthetic antioxidant in fat is to accelerate the oxidation process by rising the temperature and bubbling air through the fat sample using Rancimat or OSI apparatus. Generally, this accelerated oxidation test is run at 100°C, but for animal fat additivated with antioxidants, the induction period measured with this test method is far too long for quality control (50 - 100 hours). In order to reduce the duration of the test, both the effect of the temperature variation and the addition of pro-oxidant substances, were studied.

Material and methods

A 743 Rancimat (Methröm) model was used. Figure 1 presents the principle of this apparatus. Rapid production of volatile acids at the end of the Induction Period (IP), expressed in hours, induces an increase of the water conductivity. Samples of lard were spiked with either 100 mg/kg of Tocopherols, 100 mg/kg of Propyl Gallate (PG), 250 mg/kg of Butylated Hydroxy-Anisole (BHA) or 100 mg/kg of Butylated Hydroxy-Toluene (BHT).

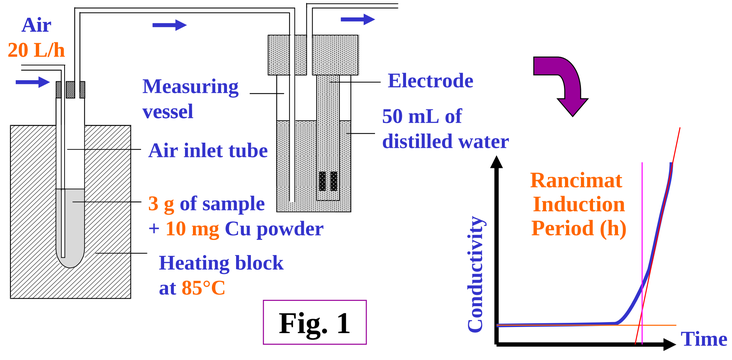


Fig. 1

Fig. 2 Effect of rising the temperature

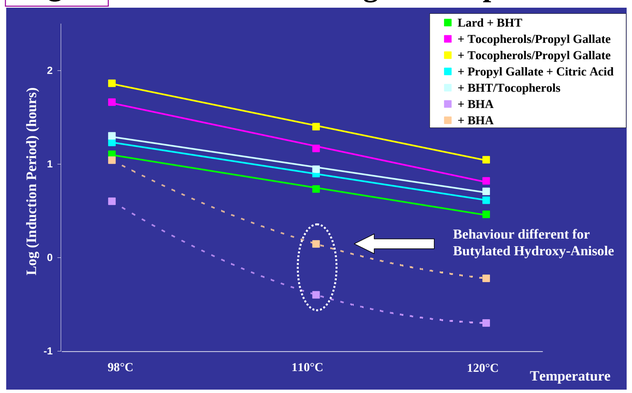


Fig. 3 Effect of adding organic copper

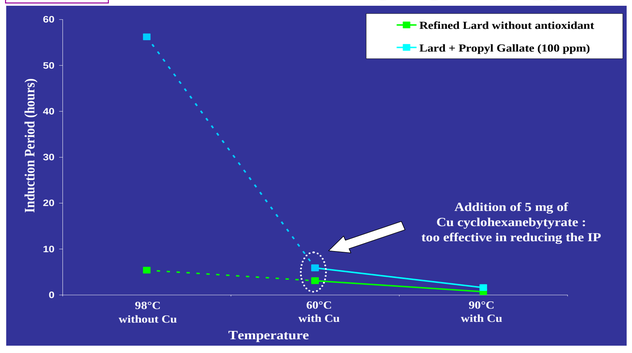
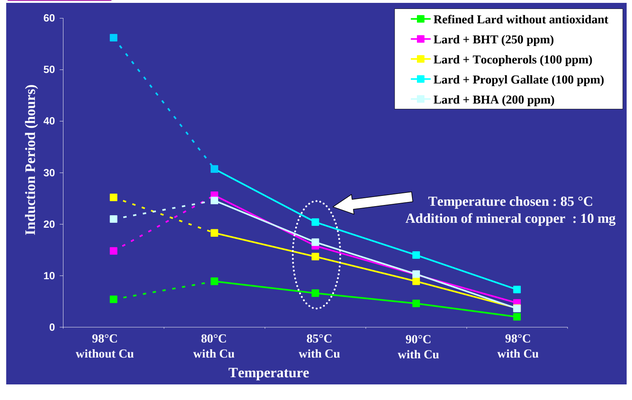


Fig. 4 Effect of adding mineral copper



Results and discussion

First trials were done by increasing the temperature of Rancimat test to 110 - 120°C. Working at higher temperature than 100°C induces a loss, by degradation or by vapor stripping, of antioxidants added in fat such as BHA. This phenomena is well demonstrated when drawing the variation of Log (IP) according to the temperature of Rancimat test (fig. 2). BHA curves present a strong decrease that is not linear contrary to other antioxidants tested.

Then, rising the temperature higher than 100°C is not the best way for efficiency comparison of synthetic antioxidant because it does not reflect the results that would be obtained at lower temperature as 98°C.

Another way to reduce the IP was to add copper (Cu) or iron that are well known pro-oxidant metals. However, organic copper like cyclohexanebutyrate Cu, was considered as too efficient in reducing IP (fig. 3).

Mineral copper in powder, added directly in the oxidation cell, presents intermediate efficiency (fig. 4). In order to keep a clear discrimination between antioxidant activity comparable to the one obtained in absence of Cu, the temperature of the Rancimat test was reduced to 85°C. In these conditions, BHA effectiveness is not underestimated.

Conclusion

Increasing the Rancimat temperature higher than 100°C disadvantages antioxidants, such as BHA, that are more readily lost than others.

Addition of small amount of copper (10 mg) to fat sample reduces the Rancimat test duration and allows to work at lower temperature (85°C). IP is reduced to acceptable duration, less than 30 hours. Repeatability standard deviation is lower than 3%. Discrimination between antioxidant efficiency is maintained with these analytical conditions.