

Accelerated shelf life test method with arrhenius approach for shelf life estimation of tongkol 'euthynnus affinis' balado in cans

by Aulia Brilliantina

Submission date: 17-Feb-2022 06:34AM (UTC+0700)

Submission ID: 1764158269

File name: liantina_2022_IOP_Conf._Ser._Earth_Environ._Sci._980_012038.pdf (540.91K)

Word count: 3039

Character count: 16118

PAPER · OPEN ACCESS

Accelerated shelf life test method with arrhenius approach for shelf life estimation of tongkol 'euthynnus affinis' balado in cans

To cite this article: A Brilliantina *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **980** 012038

View the [article online](#) for updates and enhancements.

You may also like

- [The potential of ecotourism development through community involvement to enhance tourism destination performance in Tana Toraja \(An implementation of ecotourism concepts on Banua Tongkonan\)](#)
A S Girikallo, OR Payangan, Madris et al.
- [The Shelf-life Prediction of Sweet Orange Based on Its Total Soluble Solid by Using Arrhenius and Q 10 Approach](#)
Rita Khathir, Ria Yuliana, Raida Agustina et al.
- [Marketing mix development analysis of preserved tongkol \(*Euthynnus affinis*\) on customer satisfaction in Malang, East Java, Indonesia](#)
C A Intyas and M Primyastanto



ECS The Electrochemical Society
Advancing solid state & electrochemical science & technology

242nd ECS Meeting
Oct 9 – 13, 2022 • Atlanta, GA, US

Abstract submission deadline: **April 8, 2022**

Connect. Engage. Champion. Empower. Accelerate.

MOVE SCIENCE FORWARD

Submit your abstract

The banner features a teal background with white text. On the right side, there are two images: the top one shows a group of people in a professional setting, and the bottom one shows a city skyline with a river and trees in the foreground.

Accelerated shelf life test method with arrhenius approach for shelf life estimation of tongkol ‘*euthynnus affinis*’ balado in cans

A Brilliantina¹, D K Wardani^{2*}, PT Fadhila¹, B Hariono¹ and R Wijaya¹

¹Department of Agriculture Technology, Politeknik Negeri Jember, Indonesia

²Department of Agribusiness Management, Politeknik Negeri Jember, Indonesia

dyahwardani@polije.ac.id

Abstract. Many people in Indonesia consumed tongkol fish by processing it into balado tongkol. The process carried out to extend the shelf life of the product is by packing it in cans. Information related to shelf life was needed for canned food, so that it can guarantee that the food was still good for consumption. This study aims to determine the shelf life of balado tongkol in cans from TEFA Fish Canning with the Arrhenius method. Arrhenius is the method of estimating shelf life used was ASLT (Accelerated Shelf Life Test). The ASLT method requires a relatively short testing time with an acceptable level of accuracy. This research was conducted at the TEFA Fish Canning and Food Processing Laboratory of Politeknik Negeri Jember in March – July 2021. Estimating the shelf life used the reaction approach that increases the TBA number as a critical parameter. The kinetic reaction of increasing the TBA number in canned balado tongkol followed the ordo 0 reaction. The results showed that the shelf life of balado tongkol in cans at room temperature was 24,6 weeks.

1. Introduction

Food is the most important basic of human need and its fulfillment is also part of human rights [1]. Food can be interpreted as derived from both treated and untreated biological sources and water. [2]. Public protection from unsafe food circulation is a guarantee that must be obtained by the community as consumer. Shelf life is directly related to the safety of the product and product quality assurance so as not to endanger the health of consumers. The fisheries sub-sector is the main source of food and nutrition for the people of Indonesia. Besides being a source of protein, fish is also recognized as a 'functional food' which has important meaning for health since it contains long-chain unsaturated fatty acids (especially those belonging to omega-3 fatty acids), macro and micro minerals, and vitamins. During the storage process, fish and processed fish products can undergo unwanted changes so as to limit storage time. These changes include protein oxidation ([3]; [4]) and lipid oxidation ([5]; [6]). One of the most commonly consumed fish is tongkol.

Tongkol is a commodity that rapidly declines in quality, in other words, it is easy to decompose because its high level of protein and water is easier to spoilage bacteria to grow [7]. One way to extend the shelf life of tongkol is by the canning process. Canning is one way of preserving food through processing method that is packaged hermetically or using a very tight, watertight, airtight cover so as to



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

Published under licence by IOP Publishing Ltd

minimize oxidation damage and changes in taste and then sterilize [8]. This study aims to determine the shelf life of a product from TEFA Fish Canning with the Arrhenius method.

2. Research methods

This research done in the Food Processing Laboratory and TEFA Fish Canning, Jember State Polytechnic for 6 months, from February to July 2021. The production process of balado tongkol in can is first carried out by the fish sorting process, followed by the exhausting process. After this, the process of filling the balado seasoning into the tongkol which will be canned is carried out. After the can is closed then the sterilization process is done. The research completed in several stages, (1) testing the production process; (2) identification of critical quality parameters and determination of shelf life.

The expiry date of the Balado Tongkol in can is determined by the accelerated method (Accelerated Shelf-life Testing or ASLT) with the Arrhenius model. Model selection is based on the consideration that the damage of balado seasoning tongkol is suspected to be caused by chemical changes in the food components during storage which could be triggered by storage temperature.

There are 30 cans of Balado tongkol in cans, where each can contains 115gr of Balado tongkol. Storage is carried out at three temperatures, which are 35°C, 45°C, and 55°C. There are 10 cans for each storage temperature. Observations during storage is carried out at the beginning of storage or day 0, within an interval of 1 week in along 1 month. Each observation is conducted on two cans (2 replicates) per each can and storage temperature. Observations are made on the critical parameters of TBA number using the distillation method.

3. Principle of estimating shelf life

The method of determining shelf life can be done by putting away the product until it is damaged under normal storage condition. This method produces the most valid information, but it takes time and impractical for industrial application. Therefore, an accelerated shelf-life testing or ASLT method was developed for estimating shelf life, where the product is kept under extreme storage conditions that can accelerate its deterioration. Shelf life is estimated using a mathematical model, where the factors that can affect product damage are included in the mathematical model [9]. The ASLT method requires a relatively short testing time with an acceptable level of accuracy. The more valid the mathematical model used, the more valid the prediction will be.

ASLT method oftenly used for estimating shelf life are the critical moisture content model and the Arrhenius model. The critical moisture content model is applied to estimate the shelf life of damaged food product by the water absorption of the product. The Arrhenius model is applied to foods that are easily damaged by chemical reactions such as fat oxidation, protein denaturation, Maillard reaction, etc.

The Arrhenius model is carried out by storing food product in final packaging stage at least of three extreme storage temperatures. Experiment with the Arrhenius method aims to determine the reaction rate constant (k) at several extreme storage temperatures, extrapolation then carried out to calculate the reaction rate constant (k) at the desired storage temperature using the Arrhenius equation (equation 1). From this equation, it can be determined the value of k (constant of quality degradation) at the storage temperature of the shelf life. The Arrhenius model equation to determine shelf life is expressed by equation (1).

$$k = k_0 \cdot \exp(-E_a/RT) \dots\dots\dots(1)$$

where :

K = constant of deterioration rate

K₀ = constant (frequency factor of independent temperature)

E_a = activation energy

T = absolute temperature (K)

R = gas constant (1,986 cal/mol K)

4. Results and discussion

4.1 Determination of the critical point

Determination of critical parameters used in estimating shelf life is specific for each product. In canned balado tongkol, the critical quality parameter of TBA number is used as an approach in estimating shelf life. Degradation of polyunsaturated fatty acids (PUFA) during storage leads to the formation of volatile components combined with rancidification [10]. A high percentage of unsaturated fatty acids means that fish tissue is easily pre-oxidized and quickly degraded. Oxidative changes are mainly related to the taste and texture of the fish. Changes in color, nutritional value or secondary product of lipid will be observed at an advanced stage of the lipid peroxidation process [11]. Oxidation of fish lipids is usually based on analysis of refractive index, peroxide value (PV) and reactive 2-thiobarbituric acid (TBARS) as indicators of primary and secondary oxidation products ([12]; [13]; [14]; [15]; [16]).

Table 1. Slope values, interceptions and determination on ordo 0 and ordo 1 reactions increasing of the TBA value in tongkol balado in cans

| T (°C) | Regression Equation | | R2 | |
|--------|------------------------|------------------------|---------------|--------|
| | ordo 0 | ordo 1 | ordo 0 | ordo 1 |
| 35 | $y = 0,1111x + 0,4226$ | $y = 0,182x - 0,8367$ | 0,9527 | 0,9312 |
| 45 | $y = 0,2295x + 0,4208$ | $y = 0,2886x - 0,7866$ | 0,9763 | 0,942 |
| 55 | $y = 0,3248x + 0,4102$ | $y = 0,3439x - 0,7432$ | 0,9742 | 0,9391 |

4.2 Reaction ordo determination

The speed of quality change of each product parameter is different. If the rate of damage is constant or linear, it follows the ordo 0 reaction. However, if the damage ratio is not constant, logarithmic or exponential, then an ordo 1 reaction is followed. Determination of the reaction ordo is a way to predict deterioration in quality in estimating shelf life. In kinetic reactions, food quality degradation follows ordo 0 and ordo 1. Ordo 0 can be detected by plotting between values of TBA as the Y axis and storage time as the X axis. Ordo 1 can be detected by plotting the value of ln TBA number as the Y axis and storage time as the X axis. The choice of ordo reaction can be seen by plotting the quality degradation data following the ordo 0 and ordo 1, then the linear regression equation is made. The reaction ordo with a larger R2 value is the reaction ordo used [17].

The value of determination (R2) for the increase in TBA number in the ordo 0 reaction is higher than the ordo 1 reaction (Table 1). The value of determination (R2) of ordo 0 in canned tongkol balado ranged from 0.9527 to 0.9763. Thus, it can be seen that the reaction kinetics of the increase in the TBA number during storage of Balado tongkol fish product in the package follow the pattern of ordo 0 reaction. The higher the value of determination, the more accurate the result of the data analysis. The positive slope value indicates an increase in the TBA number in canned balado tongkol (Table 1). The value of the gradient or slope (k) states the relationship between the value of quality degradation and storage time. This is in accordance with [18] which showed an increase in the number of TBA (Thiobarbituric Acid) in andaliman sauce during storage. The increase in TBA number in this product is due to the heat-induced oxidation reaction. In the appearance of tomato paste, the brightness of the color also decreased to become more brownish due to lycopene oxidation [19].

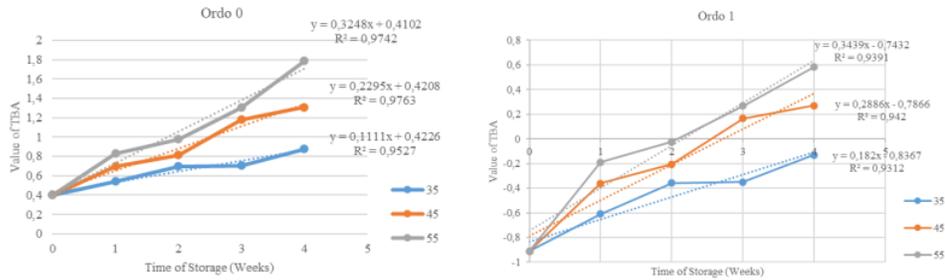


Figure 1. Graphic of relationship of value of TBA degradation to time

4.3 Shelf life estimation

According to [20], The shelf life is the period until the quality of the product deteriorates, and it does not meet the standards specified on the packaging and should not be eaten. (the quality is not yet in the guaranteed quality level), due to the ongoing deterioration reaction. The deterioration reaction leads to poor quality and poor quality of the product, making it unsuitable for consumption. This deterioration reaction will cause changes to the canned balado tongkol fish product. Determination of the critical value of tongkol balado in can is obtained from the TBA number assessment parameter. Response order selection is made by plotting the degradation data after response ordo 0 and response ordo 1, and then writing a linear regression equation.

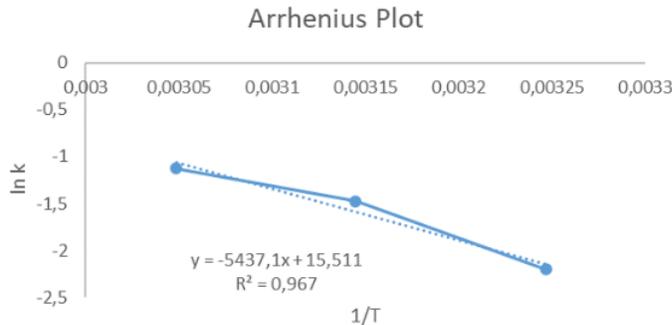


Figure 2. Graphic of TBA value arrhenius plot

The shelf life of tongkol balado fish product in can, assuming the temperature in room temperature of 25°C for 24,6 weeks (24 months 18 days). [21] state that oxidation can lead to the formation of off-flavor compounds and this condition is called rancid. It is the process of breaking down fat. Due to oxidation of unsaturated fatty acids, rancid processes foods lose nutritional value and cause discoloration, which affects quality. Oxidized compounds such as peroxides, ketones, and aldehydes are harmful to human health. While [22] stated that factors affecting the rate of oxidation include the chemical structure of lipids, the amount and type of oxygen, the presence of antioxidant and pro-oxidant compound, the nature of packaging materials, and storage temperature.

5. Conclusion

Estimating the shelf life of tongkol balado in can using the ASLT method by using the reaction approach of increasing the TBA values as a critical parameter. The kinetic reaction of increasing the TBA number in canned balado tongkol followed the ordo 0 reaction. Shelf life of tongkol balado in can using the

ASLT method through an approach of critical parameter of the TBA number at room temperature 25 °C has a shelf life of 24,6 months.

Acknowledgements

This paper is dedicated to Politeknik Negeri Jember. This paper is part of the 2021 Higher Education grant applied research.

References

- [1] Hermanuadi, D. Brilliantina, A, and Sari, E.N. 2020. *IOP Conf. Series: Earth and Environmental Science* **411**: 012016
- [2] Kurnianto M F, Wibowo M J, Hariono B, Wijaya R, Brilliantina A. 2020. *IOP Conf. Ser.: Earth Environ. Sci.* **411** 012051
- [3] Fijuwara, K., Oosawa, T. dan Saeki, H. 2008. Improved thermal stability and emulsifying properties of carp myofibrillar proteins by conjunction with dextran. *Journal of Agricultural and Food Chemistry* **46**: 1257–1261
- [4] Benjakul, S., Viessanguan, W., Thongkaew, C. dan Tanaka, M. 2005. Effect of frozen storage on chemical and gel-forming properties of fish commonly used for surimi production in Thailand. *Food Hydrocolloids* **19**(2): 197–207
- [5] Sarma, J., Reddy, G.V.S. dan Srikar, L.N. 2000. Effect of frozen storage on lipids and functional properties of proteins of dressed Indian oil sardine (*Sardinella longiceps*). *Food Research International* **33**: 815–820
- [6] Richards, M.P. dan Hultin, H.O. 2012. Contributions of blood and blood components to lipid oxidation in fish muscle. *Journal Agriculture Food Chemistry* **50**: 555–564
- [7] Nabila, L., Tamrin., K.T Isamu. 2017. Karakterisasi organoleptik, kimia, dan mikroba ikan kayu cakalang (*Katsuwonus pelamis*) dan ikan kayu tongkol (*Euthynnus affinis*) yang diproduksi di kota kendari. *Jurusan Sains dan Teknologi Pangan*, Volume **2** (3). P. 530-541
- [8] Muntikah dan M. Razak. 2017. Ilmu teknologi pangan. Kemenkes RI: Pusat Pendidikan Sumber daya Manusia Kesehatan
- [9] Floros, J.D. dan V. Gnanasekharan. 1993. Shelf Life Prediction of Packaged Foods: Chemical, Biological, Physical, and Nutritional Aspects. Di dalam Chlaralambous, G (Ed.). *Instrumental Methods in Food and Beverage Analysis*. Elsevier Publ., London.
- [10] Pazos, M., Gallardo, J.M., Torres, J.L. dan Medina, I. 2005. Activity of grape polyphenols as inhibitors of the oxidation of fish lipids and frozen fish muscle. *Food Chemistry* **92**: 547–557.
- [11] Dragoev, S.G., Kiosev, D.D., Danchev, S.A., Ioncheva, N.I. dan Genov, N.S. 2008. Study on the oxidative processes in frozen fish. *Journal of Agriculture and Science* **4**: 55–65.
- [12] Aranda, M., Mendoza, N. dan Villegas, R. 2005. Lipid damage during frozen storage of whole jack mackerel (*Trachurus symmetricus* Murphy). *Journal of Food Lipids* **13**: 155–166
- [13] Chaijan, M., Benjakul, S., Viessanguan, W. dan Faustman, C. 2006. Changes of lipids in sardine (*Sardinella gibbosa*) muscle during iced storage. *Food Chemistry* **99**: 81–83.
- [14] Pourashouri, P., Shabanpour, B., Aubourg, S.P., Rohi, J.D. dan Shabani, A. 2009. Aninvestigation of rancidity inhibition during frozen storage of Wels catfish (*Silurus glanis*) fillet by previous ascorbic and citric acid treatment. *International Journal of Food Science and Technology* **44**: 1503–1509.
- [15] Quitral, V., Donoso, M.L., Ortiz, J., Herrera, M.V., Araya, H. dan Aubourg, S.P. 2009. Chemical changes during the chilled storage of Chilean jack mackerel (*Trachurus murphyi*): Effect of a plant-extract icing system. *LWT–Food Science and Technology* **42**: 1450–1454.
- [16] Yerlikaya P, and Gokogku N. 2010. Inhibition effects of green tea and grape seed extract on lipid oxidation ini bonito fillet during frozen storage. *International Journal of Food Science and Technology* **45**: 252-257.

- [17] Arif, A. Bin. 2016. Metode Accelerated Shelf Life Test (ASLT) Dengan Pendekatan Arrhenius Dalam Pendugaan Umur Simpan Sari Buah Nanas, Pepaya Dan Cempedak. *Informatika Pertanian*, **25(2)**, 189–198
- [18] Bancin, L. H. 2018. Pengaruh Penambahan Gum Arab Terhadap Mutu Sambal Andaliman dan Penentuan Umur Simpannya. Universitas Sumatera Utara
- [19] Sikora, M., Badrie, N., Deisingh, A. K., Kowalski, S. 2008. Sauces and Dressing: A Review of Properties and Applications. *Critical Reviews in Food Science and Nutrition*, **1(1)**, 50–77
- [20] Arpah, M., Syarif, R. 2000. Evaluasi Model Model Pendugaan Umur Simpan Pangan dari Difusi Hukum Fick Unidireksional. *Buletin Teknologi Dan Industri Pangan*, **XI(1)**, 11–16
- [21] Secbecic, N. dan Beutelspecher, S.C. 2005. Anti-oxidative vitamins prevent lipid-peroxidation and apoptosis in corneal endothelial cell. *Cell Tissue Respirative* **320**: 465–475
- [22] McClements, D.J. dan Decker, E.A. 2000. Lipid oxidation in oil-in-water emulsions: Impact of molecular environment on chemical reaction in heterogeneous food system. *Journal of Food Science* **65**: 1270–1282.

Accelerated shelf life test method with arrhenius approach for shelf life estimation of tongkol 'euthynnus affinis' balado in cans

ORIGINALITY REPORT

10%

SIMILARITY INDEX

7%

INTERNET SOURCES

14%

PUBLICATIONS

6%

STUDENT PAPERS

PRIMARY SOURCES

- 1** Submitted to Udayana University 4%
Student Paper
- 2** Rahim Husain, Rieny Sulistijowati. "Effect of Temperature and Long Storage of Fatty Acid Profile, Value Peroxide and Value TBA Fillet of Snapper (Lutjanus sp)", Current Journal of Applied Science and Technology, 2019 2%
Publication
- 3** pure.aber.ac.uk 2%
Internet Source
- 4** S D Astuti, S Lestari, Erminawati, S Widarni, G Wijanarko, F N Wibawa. "Shelf life prediction of carica seeds powder using accelerated method", IOP Conference Series: Earth and Environmental Science, 2021 2%
Publication

Exclude quotes On

Exclude bibliography On

Exclude matches < 2%