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Research Article

Effect of Tamarind (*Tamarindus indica*) Solution at Different Concentrations on Lead Content of Smoked Catfish (*Pangasius* sp)

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Abstract:
This research aims to study the effect of soaking smoked catfish in tamarind solution at various concentrations on its heavy metal content. A completely randomized design with one treatment used in the study, and concentrations of tamarind solution with four treatment levels were applied namely: 0% (A0 or control), 5% (A1), 10% (A2) and 15% (A3), each treatment with three repetitions. The lead (Pb) analysis showed that the control smoked catfish (A0) contained 0.307µg/g of Pb, exceeding the safe limit set by the Indonesian National Standardization Agency (BSN). Soaking in tamarind solution significantly reduced the Pb content in A1, A2, and A3 [by 89.57% (0.032µg/g), 97.39% (0.008µg/g) and 91.85% (0.025µg/g), respectively]. The hedonic test showed that the aroma and taste were significantly different. In addition, Post hoc test results revealed that the aroma of A1, A2 and A3 was significantly different from the control (A0); the taste of A1, A2 and A3 was significantly different from the control (A0); A1 was significantly different from A3. Based on the results, it could be concluded that the best treatment was A2 (10%).

Keywords: Chelating Agent, Heavy Metal (Pb), Sensory Evaluation, Smoked Catfish, Tamarind

1. INTRODUCTION

Catfish (*Pangasius* sp) is one of the fish that is quite popular with the public, it is a fish that is quite easy to get and the price of the fish is quite cheap. Fresh catfish is prone to spoilage so treatment is needed to prevent catfish spoilage, including processing the fish using the smoking method (Ningsih et al., 2021).

Smoking is one type of fish processing that could maintain shelf life because the processing process reduces the water content so that it could inhibit the growth of microorganisms in the fish. Smoking provides a distinctive aroma, taste, texture and color due to the chemical reactions that occur when burning wood.

Previous research revealed that smoked fish that is traditionally processed and sold can be easily contaminated with environmental conditions, including lead metal (Fuadi et al., 2016). Because this could be caused by smoking and sales facilities where the location is directly adjacent to a highway with quite a lot of motorized traffic.

Lead (Pb) is one of the toxic metals because it could disrupt health, including the kidneys and nervous system, which could ultimately cause convulsions, coma and even death. Even though contamination has little impact on food, over time it will accumulate in the body (Putra et al., 2023). The National Standardization Agency by SNI 7387:2009 determines the maximum limit for Pb in fish and its products at 0.300 mg/kg (BSN, 2009).

Previous research study showed that the citric acid found in tamarind is the best type of acid in reducing lead metal levels in anchovies (Sipa et al., 2016). Citric acid has three COOH carboxyl groups that could release protons in solution. The ion produced is citrate ion. This ion could react with metal ions to form citrate salt. This citrate is intended as a chelator (Kartikasari et al., 2021).

This research aims to study the effect of tamarind solution at different concentrations on the Pb content in smoked catfish sold in I Epil Village, Lais District, Musi Banyuasin Regency, South Sumatra Province, Indonesia.

To the best of our knowledge, this is the first work that deals with the application of tamarind solution to reduce the Pb heavy metal content in the smoked catfish. The present work intended to examine the

effect of tamarind solution at different concentrations on the lead (Pb) content and level of panelists acceptance using hedonic test.

2. MATERIAL AND METHOD

This research was carried out from May to June, 2024 in four places as follows: Proximate analysis of smoked catfish in the Laboratory of Chemistry and Microbiology of Agricultural Products, Department of Agricultural Technology, Faculty of Agriculture, Sriwijaya University, analysis of citric acid in tamarind in the Chemistry laboratory, Faculty of Science and Technology, UIN Raden Fatah Palembang, analysis of lead metal content in smoked catfish at the Palembang Public Health Laboratory Center and preparation and carrying out hedonic tests (color, aroma, texture and taste) of smoked catfish at the Fisheries Product Technology Workshop Laboratory, Faculty of Fisheries and Marine, University of PGRI Palembang.

The main materials used in this research were smoked catfish (*Pangasius* sp) (±350 g weight,) which were purchased from a traditional smoked catfish processor (I Epil Village, Lais District, Musi Banyuasin Regency, South Sumatra Province, Indonesia) being sold on the side of the highway after ±7 days, and tamarind (*Jeruk* brand) was purchased from a local traditional market (Palembang, South Sumatra Province, Indonesia). The chemicals used were nitric acid (68.0 - 70.0%,), selenium (99.0 - 100.5%, SeO2 in HN), boric acid (99.5 - 100.5%) which purchased from Merck (Darmstadt, Germany). All chemicals and reagents used this research were high purity and analytical grade.

Figure 1. Smoked catfish (*Pangasius* sp)

Figure 2. Tamarind (*Jeruk* brand)

The main equipments used were Inductively Coupled Plasma (ICP) (Thermo Scientific, iCAP 7000 series ICP- OES, Cambridge, UK), microwave digestion system (digestion of 12 samples, NovaWAVE SA,), and analytical balance (0.0001g, Fujitsu).

2.1 Preparation of Tamarind Solution (Tamarindus indica)

Preparation of tamarind solution using the modified method of Juliadi et al. (2018) as follows:

1. The 5% tamarind solution. The tamarind flesh was weighed (5 g), ground it using a blender, and then added mineral water to make 100 mL.
2. The 10% tamarind solution. The tamarind flesh was weighed (10 g), ground it using a blender, and then added mineral water to make 100 mL.
3. The 15% tamarind solution. The tamarind flesh was weighed (15 g), ground it using a blender, and then added mineral water to make 100 mL

2.2 Preparation of Samples

Sample preparation using the modified method of Rachman et al. (2022) as follows.

A0: Control

A1: Smoked catfish was soaked in 5% tamarind solution for 1 hour

A2: Smoked catfish was soaked in 10% tamarind solution for 1 hour

A3: Smoked catfish was soaked in 15% tamarind solution for 1 hour

2.3 Proximate Analysis

The tests were carried out for analysis of water content, ash content, fat content, protein content and carbohydrate content (by difference) according to the SNI 01-2891-1992 method (BSN, 1992).

2.4 Citric Acid Analysis

Analysis of citric acid in tamarind was carried out using the titration method according to the SNI 06-2422-1991 method (BSN, 1991).

2.5 Lead Metal (Pb) Analysis

Analysis of lead metal was done using Inductively Coupled Plasma (ICP) according to the AOAC method (Briscoe, 2015).

2.6 Hedonic Test

A test to determine the preference of panelists for the color, aroma, texture and taste of smoked fish samples according to the SNI 01 2346-2006 method (BSN, 2006). The hedonic test was involved 20 moderately trained panelists, using 5-point hedonic scale which is represented by 5 scores, namely: 5 = Like Very Much, 4 = Like, 3 = Neutral (Neither Like nor Dislike), 2 = Dislike, 1 = Dislike Very Much.

Preparation of samples was carried out by cutting the smoked catfish into cubes, weighing (± 3-5 g) and then soaking in tamarind solution for 1 hour according to the treatment. Samples for the taste were steamed before being served to the panelists.

2.7 Data Analysis

The study was used a completely randomized design with one treatment, namely the concentration of tamarind solution, with four treatment levels, namely 0% (A0 or control), 5% (A1), 10% (A2) and 15% (A3), each with three repetitions.

The obtained data were expressed as mean. A one-way analysis of variance (ANOVA) was performed to establish the statistical differences. Significant differences between means were identified using Duncan's multiple range test ($p < 0.05$). Statistical analyses were performed using IBM SPSS Statistics 20.0 (IBM SPSS software, USA).

3. RESULT AND DISCUSSION

3.1 Proximate Analysis

The proximate analysis of smoked catfish showed that water, ash, fat, and protein contents were 8.75%, 3.32%, 39.82%, and 46.12%, respectively, in addition to carbohydrate content (by difference) was 1.99%.

Water content is the amount of water contained in food which affects the shelf life of food. Processing food by smoking could reduce the water content thereby increasing its shelf life. The water content of fresh catfish had 64.42% (Ayu et al., 2020), whereas the water content result of smoked catfish in this study was low (8.75%).

Ash is an organic material that is made by burning at high temperatures, namely 500°C and above for 2-8 hours (Tahar et al., 2017). Ash content is also used as an indicator of quality in food. The previous study by Ayu et al., (2020), indicated that the ash content in fresh catfish meat had 0.83%, and based on this research, the ash content value in smoked catfish was high (3.32%). An increase of ash content is due to the decreasing water content during the smoking process (Fitriana et al., 2017).

According to Ayu et al. (2020), the fat content in fresh catfish meat had 5.77%, while for the result of smoked catfish in this study was high (39.82%). The smoking process reduces the water content in the fish as a result of fat content increases at the same weight.

The protein content in fresh catfish had 16.01% (Ayu et al., 2020) and the protein content in smoked catfish was higher (46.12%) than in the above mentioned study. High and low protein values could be influenced by the amount of water content that evaporates from the raw material. The greater the water content lost, the greater the protein value that could be measured (Pratama et al., 2014).

3.2 Citric Acid Analysis

Citric acid content of tamarind was 0.546%. The research results of Sipa et al. (2016) showed that the citric acid found in tamarind is the best type of acid in reducing lead metal levels in anchovies. Kartikasari et al. (2021) concluded that the active substances tannin and citric acid in tamarind solution could chelate Pb(II) ions to form soluble complex compounds, so that the levels of Pb(II) ions in packaged milk are reduced.

3.3 Lead Metal (Pb) Analysis

The previous research by Fuadi et al. (2016) showed that there was lead content in smoked fish purchased in I Epil Village, Lais District, Musi Banyuasin Regency, South Sumatra Province, Indonesia. This

could be caused by processing and marketing conditions which are still carried out in an open state close to the main road and there is no protection so that they are easily exposed to motor vehicle fumes.

Motor vehicle pollution in the form of gas could result from incomplete combustion of gasoline additives in vehicles, which produce various lead metal components that are harmful to health, besides air pollution from factories (Fachruli & Meikawati, 2013).

The results of lead analysis in this study showed that the Pb content in smoked catfish with an average value of 0.307 mg/kg exceeds the limit set by SNI 7387:2009 regarding maximum limit for lead contamination in fish and its processed products, namely 0.300 mg/kg (BSN, 2009). Food contaminated with lead, if consumed, can affect in the body health (Umar et al., 2021). Therefore, treatment is needed to reduce lead levels in smoked fish.

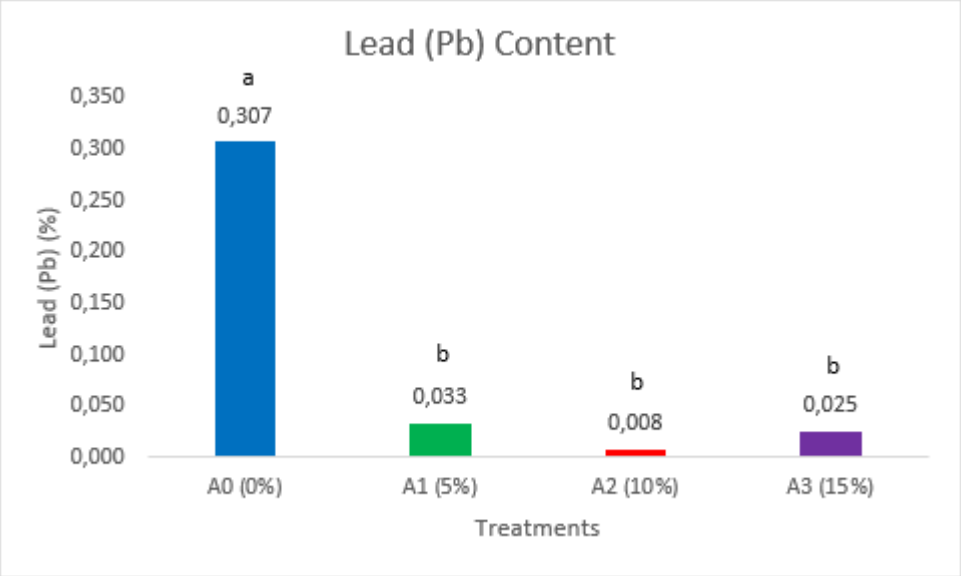

Figure 3. Effect of treatment by different levels of concentration of tamarind solution on the Pb content of the smoked catfish. Different letters (a - b) represent significant differences found by Duncan's multiple range test ($p < 0.05$, and $n = 3$)

Table 1. Percentage Reduction of Pb to Control (A0)

Treatment	Mean (%)	Pb Reduction (%)
A1 (5%)	0.033	89.36
A2 (10%)	0.008	97.29
A3 (15%)	0.025	91.86

Note: Mean of Control (A0) = 0.307%, and n = 3

Figure 3 shows the lead content of smoked catfish without treatment/control (A0) with a value of 0.307%, after treatment the lead content in the A1 (5%), A2 (10%) and A3 (15%) with values of 0.033%, 0.008% and 0.025%, respectively.

The ANOVA test showed that the tamarind soaking treatment had a significant effect on the lead content of smoked catfish. Furthermore, Duncan's multiple range test showed that the lead level of A0 significantly different from the levels of A1, A2 and A3.

As shown in Table 1, the largest reduction in lead content was in treatment A2 (10% tamarind), which is 97.29%. This is because tamarind contains a natural acid in the form of citric acid which functions as a metal chelator because the ions produced in the form of citrate ions will react with metal ions which will form citrate salts (Hardani et al., 2022).

3.4 Hedonic Test

Hedonic test or liking test is a test carried out by several panelists regarding the liking of a product which could be called a sensory test which is carried out sensorial and is transformed into numbers to see the level of liking (Su et al., 2021).

3.4.1 Color

Color is one of the first types of sensory input that panelists must see. Color could determine the condition of food ingredients, which are not very different from the color they should be (Negara et al., 2016). Among the smoked catfish, control sample (A0) recorded the highest color average value (3.70), whereas the A2 and A3 obtained the lowest color average value (3.10 and 3.20, respectively). It can be seen from the Figure 4 that the level of panelists' preference for color after treatment at a concentration of 5% and a low level at 10% treatment.

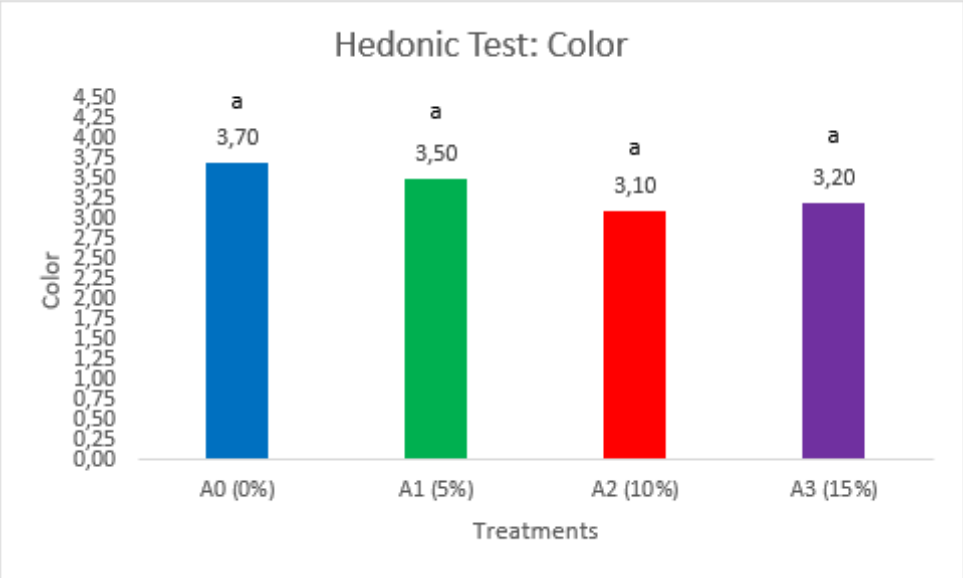

Figure 4. Effect of treatment by different levels of concentration of tamarind solution on the hedonic test color of the smoked catfish. Duncan's multiple range test ($p < 0.05$, and $n = 20$) showed no significant differences between samples.

The color of smoked catfish is produced from smoking which is carried out traditionally in an open smoking condition, the resulting color is brownish which is produced from wood compounds in the smoking process, uncontrolled smoking often occurs so that some of it burns (Muchtar & Hastian, 2023). It can be seen from the test results that the color hedonic test by soaking in tamarind solution for 1 hour does not significantly affect the typical color of smoked catfish. Duncan's multiple range test ($p < 0.05$, and $n = 20$) showed no significant differences between samples.

3.4.2 Aroma

Aroma is a sensory test carried out using the sense of smell or smell. The aroma itself aims to influence raw materials to like or dislike consumers who provide assessments (Wintah et al., 2018). Regarding the aroma, control sample (A0) recorded the highest aroma mean value (4.25), while the A1, A2 and A3 obtained the lowest aroma mean value (3.20, 3.20 and 3.15, respectively). From Figure 5, it can be noticed that the level of panelists' preference for the aroma after treatment at a concentration of 5% and a low level at 15% treatment.

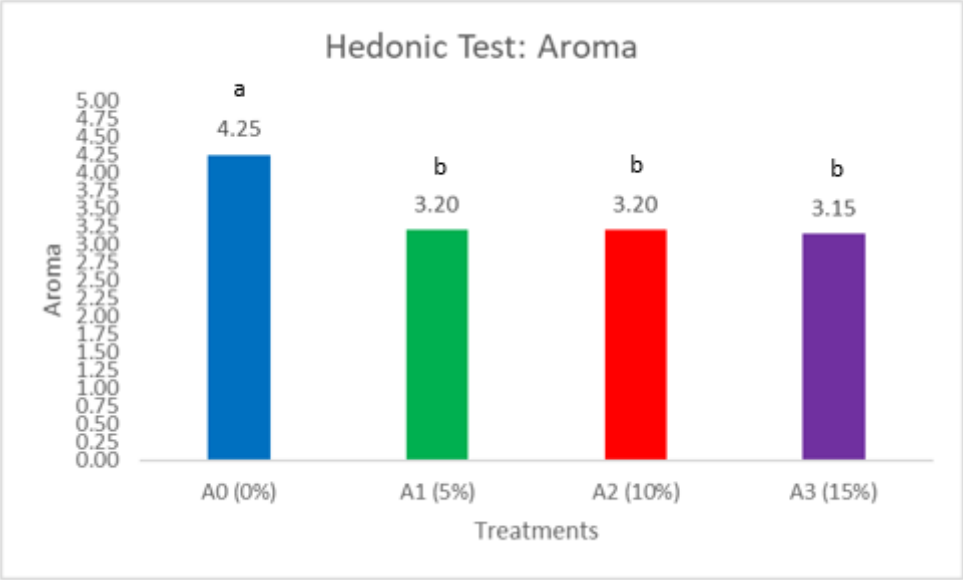

Figure 5. Effect of treatment by different levels of concentration of tamarind solution on the hedonic test aroma of the smoked catfish. Different letters (a - b) represent significant differences found by Duncan's multiple range test ($p < 0.05$, and $n = 20$)

Furthermore, based on ANOVA analysis, there was a significant influence on the aroma hedonic test in smoked catfish with different concentrations of tamarind. Duncan's multiple range test showed significant differences between control and the A1, A2, and A3 treatments.

3.4.3 Texture

Texture is an assessment that is conducted by feeling both with the senses of the mouth and seeing the texture itself which has several physical properties including shape, size, hardness, dryness, roughness, smoothness and so on (Putri & Mardesci, 2018). Among the smoked catfish samples, control (A0) and A1 exhibited high texture average values (3.30 and 3.30, respectively), whereas, the A2 and A3 recorded low texture average values (2.90 and 2.95, respectively). From the values, it can be seen that the level of panelists' preference for the texture after treatment at a concentration of 5% and the lowest was at 10% treatment.

Furthermore, based on ANOVA analysis, there was significant influence on the hedonic texture test on smoked catfish with and without treatments.

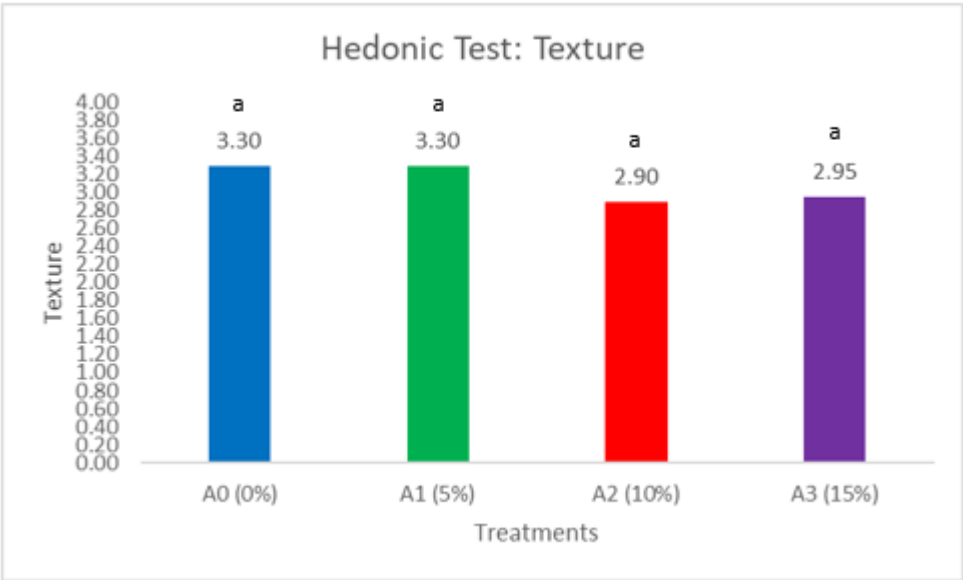

Figure 6. Effect of treatment by different levels of concentration of tamarind solution on the hedonic test texture of the smoked catfish. Duncan's multiple range test ($p < 0.05$, and $n = 20$) showed no significant differences between samples

3.4.4 Taste

Taste is one of the assessments that could influence the level of panelists' liking for food. The tongue will respond to a given product. There are various kinds of tastes that are given, including sweet, salty, sour, bitter so that consumers could feel their likes and dislikes for a product (Syifadhiya & Farapti, 2023).

As in the result, the control sample (A0) had the highest taste value (3.85), whereas A3 sample exhibited the lowest taste value (2.35). The mean values of taste decreased with an increasing of tamarind solution concentrations. It can be noticed that the level of panelists' preference for the taste after treatment at a concentration of 5% and a low level at 15% treatment.

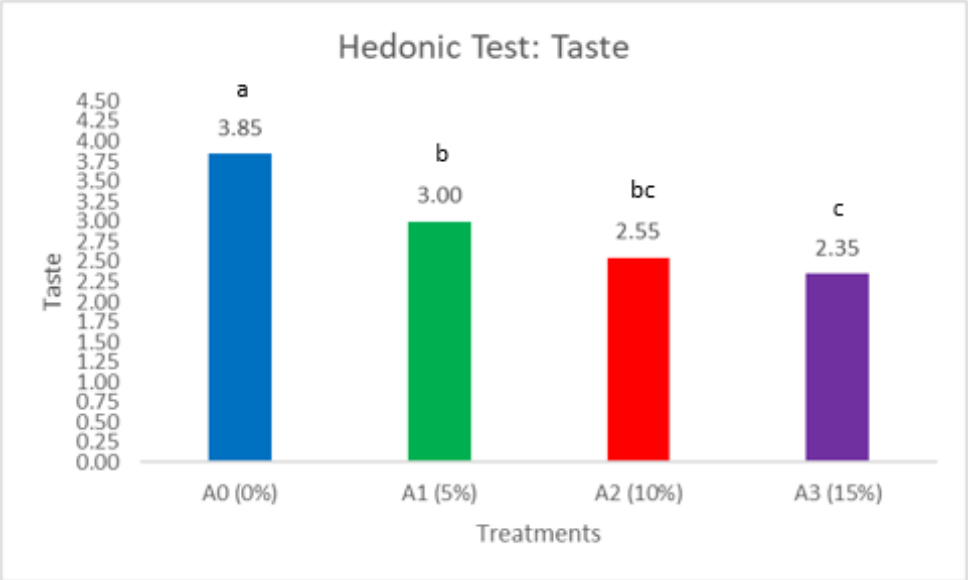

Figure 7. Effect of treatment by different levels of concentration of tamarind solution on the hedonic test aroma of the smoked catfish. Different letters (a - c) represent significant differences found by Duncan's multiple range test ($p < 0.05$, and $n = 20$)

Furthermore, based on ANOVA analysis, there is a significant effect on the hedonic taste test of smoked catfish with differences in concentration. Duncan's multiple range test showed that there are significant differences among all the smoked catfish samples (Figure 7). The taste produced by smoked fish comes from phenolic compounds from the wood used as a source in smoking, so that the resulting taste has a distinctive taste (Fransiska et al., 2021). From the results of the test that have been carried out, the soaking treatment in tamarind solution affects the taste of smoked fish so it has a sour tamarind taste.

4. CONCLUSION

Based on the results of this research, it can be concluded that tamarind (*Tamarindus indica*) has a citric acid content of 0.546%, which functions as a chelating agent for lead metal (Pb). The proximate analysis of smoked catfish showed low in water content and high in ash, fat and protein contents compared to a previous study of fresh catfish. In addition, treatment of smoked catfish with tamarind solution at different concentrations reduced lead levels in the treated samples (the best treated sample was A2). Moreover, the results of the hedonic test (color, aroma, texture and taste) revealed that no significant differences between A2 and control (A0) on color and texture. Further research is needed to increase preference of panelists for the aroma and taste of smoked catfish treated with tamarind solution.

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REFFERENCE

Ayu, D. F., Sormin, D. S., & Rahmayuni, R. (2020). Karakteristik Mutu dan Sensori Nugget Ikan Patin (Pangasius hypopthalmus) dan Nangka (Artocarpus heterophyllus) Muda. *Jurnal Teknologi Dan Industri Pertanian Indonesia*, *12*(2), 40–48. https://doi.org/10.17969/jtipi.v12i2.15638

Briscoe, M. (2015). Determination of Heavy Metals in Food by Inductively Coupled Plasma--Mass Spectrometry: First Action 2015.01. *Journal of AOAC International*, *98*(4), 1113. https://doi.org/10.5740/jaoac.int.2015.01

BSN. (1991). SNI 06 2422 1991: Metode Pengujian Keasaman dalam Air dengan Titrimetrik. In *Standar Nasional Indonesia* (p. 2422).

BSN. (1992). *SNI 01 2891 1992: Cara Uji Makanan dan Minuman*.

BSN. (2006). SNI 01 2346 2006: Petunjuk Pengujian Organoleptik dan atau Sensori. *BSN (Badan Standarisasi Nasional)*, 2–14.

BSN. (2009). SNI 7387:2009. Batas Maksimum Cemaran Logam Berat dalam Pangan. *Batas Maksimum Cemaran Logam Berat Dalam Pangan*, 1–29.

Fachruli, N., & Meikawati, W. (2013). Perbedaan Kadar Timbal (Pb) Di Udara Badan Jalan Berdasarkan Kerapatan Tanaman Penghijauan Dan Densitas Kendaraan Bermotor Di Kota Semarang. *J. Kesehat. Masy. Indones*, *8*(1), 18–25. https://doi.org/10.26714/jkmi.8.1.2013.18-25

Fitriana, A., Harun, N., Yusmarini, D., Teknologi, S., Pertanian, H., Pertanian, J. T., & Pertanian, F. (2017). The Quality of Herbal Tea Leaves Keji Beling With Drying Time Treatment. *Sagu*, *16*(2), 34–41. https://doi.org/10.31258/sagu.v16i2.5407

Fransiska, D., Marniza, M., & Silsia, D. (2021). Physical, Organoleptic and Food Fiber Characteristics of Sweet Bread with Addition of Bamboo Flour (Dendrocalamus asper). *Jurnal Agroindustri*, *11*(2), 108–119. https://doi.org/10.31186/j.agroindustri.11.2.108-119

Fuadi, A., Supriadi, A., & Nopianti, R. (2016). Evaluasi Keamanan Ikan Asap di Dusun I Epil Kecamatan Lais Kabupaten Musi Banyuasin. *Jurnal FishtecH*, *4*(2), 148–157. https://doi.org/10.36706/fishtech.v4i2.3509

Hardani, P. T., Intan Ayu Kusuma Pramushinta, & Ira Purbosari. (2022). Penyuluhan Pemanfaatan Belimbing Wuluh (Oreochromis Mossambicus Dan Asam Sitrat Untuk Mengurangi Cemaran Logam Berat Pada Ikan. *Pancasona*, *1*(1), 23–28. https://doi.org/10.36456/pancasona.v1i1.6153

Juliadi, D., Yuliasih, N. W., Pramitha, D. A. I., & Agustini, N. P. D. (2018). Uji Pengaruh Variasi Konsentrasi Perendaman Larutan Asam Jawa Terhadap Penurunan Kadar Formalin Pada Sosis. *Medicamento*, *4*(2), 71–77. https://doi.org/10.36733/medicamento.v4i2.853

Kartikasari, A., Mukaromah, A. H., & Sulistyaningtyas, A. R. (2021). Efektivitas Larutan Asam Jawa (Tamarindus Indica) 5%b/v Dengan Variasi Waktu Perendaman Terhadap Penurunan Kadar Ion Pb(II) Pada Susu Kemasan Kaleng. *Prosding Seminar Nasional UNIMUS*, *4*, 1861–1868. Google Scholar

Muchtar, F., & Hastian, H. (2023). Analisis Karakteristik Organoleptik Ikan Tuna Asap Yang Dihasilkan Dengan Metode Pengasapan Tradisional Di Desa Malalanda Kecamatan Kulisusu Kabupaten Buton Utara. *Jurnal Pertanian Khairun*, *2*(1), 141–146. https://doi.org/10.33387/jpk.v2i1.6318

Negara, J. K., Sio, A. K., Rifkhan, R., Arifin, M., Oktaviana, A. Y., Wihansah, R. R. S., & Yusuf, M. (2016). Aspek mikrobiologis, serta Sensori (Rasa, Warna,Tekstur, Aroma) Pada Dua Bentuk Penyajian Keju yang Berbeda. *Jurnal Ilmu Produksi Dan Teknologi Hasil Peternakan*, *4*(2), 286–290. https://doi.org/10.29244/jipthp.4.2.286-290

Ningsih, R. K., Rastina, & Abrar, M. (2021). Deteksi cemaran Escherichia coli pada ikan patin asap (Pangasius sutchi) di Desa Koto Masjid Kabupaten Kampar, Riau. *Jurnal Ilmiah Mahasiswa Veteriner (JIMVET)*, *5*(1), 62–67. https://doi.org/10.21157/jim%20vet..v5i1.14666

Pratama, R. I., Rostini, I., & Liviawaty, D. E. (2014). Karakteristik Biskuit dengan Penambahan Tepung Tulang Ikan Jangilus (Istiophorus Sp.). *Jurnal Akuatika*, *5*(1), 30–39. Google Scholar

Putra, A., Fitri, W. E., & Febria, fuji astuti. (2023). Toksisitas Logam Timbal Terhadap Kesehatan Dan Lingkungan. *Jurnal Kesehatan Medika Saintika*, *14*(1), 158–174. https://doi.org/10.30633/jkms.v14i1.1890

Putri, R. M. S., & Mardesci, H. (2018). Uji Hedonik Biskuit Cangkang Kerang Simping (Placuna placenta) Dari Perairan Indragiri Hilir. *Jurnal Teknologi Pertanian*, *7*(2), 19–29. https://doi.org/10.32520/jtp.v7i2.279

Rachman, F. I., Rahmadani, R., & Rizal, M. (2022). Penurunan Kadar Logam Timbal (Pb) Pada Daging Ikan Kelabau (Osteochilus melanopleurus) Dengan Filtrat Asam Jawa (Tamarindus indica). *Journal Pharmaceutical Care and Sciences*, *3*(1), 61–67. https://doi.org/10.33859/jpcs.v3i1.217

Sipa, Y. N., Jamaluddin, J., & Ihwan, I. (2016). Pengaruh Jenis Asam Alami Terhadap Penurunan Kadar Logam Berat Timbal Dalam Daging Ikan Teri (Stelophorus indicus Sp) Asal Teluk Palu. *Kovalen*, *2*(3), 80–85. https://doi.org/10.22487/j24775398.2016.v2.i3.7539

Su, T. C., Yang, M. J., Huang, H. H., Kuo, C. C., & Chen, L. Y. (2021). Using sensory wheels to characterize consumers' perception for authentication of taiwan specialty teas. *Foods*, *10*(4), 1–17. https://doi.org/10.3390/foods10040836

Syifadhiya, Q., & Farapti, F. (2023). Association between Salty Taste Threshold and Hypertension among Adolescents in Surabaya. *Amerta Nutrition*, *7*(4), 487–493. https://doi.org/10.20473/amnt.v7i4.2023.487-493

Tahar, N., Fitrah, M., & David, N. A. M. (2017). Penentu Kadar Protein Daging Ikan Terbang (Hyrundicthys oxycephalus) Sebagai Substitusi Tepung Dalam Formulasi Biskuit. *Jurnal Farmasi*, *5*(36), 251–257. https://doi.org/10.24252/jurfar.v5i4.4467

Umar, R. R., Umboh, J. M. L., & Akili, R. H. (2021). Analisis kandungan timbal (Pb) pada makanan jajanan gorengan di pinggiran jalan raya Kec. Girian Kota Bitung Tahun 2021. *Jurnal Kesmas*, *10*(5), 84–93. Google Scholar

Wintah, W., Heriyanti, A. P., & Kiswanto, K. (2018). Kajian Nilai Gizi Dan Organoleptik Cokelat Mangrove Dari Buah Sonneratia Alba. *Jurnal Litbang Kota Pekalongan*, *15*, 26–34. https://doi.org/10.54911/litbang.v15i0.74