This conference was conducted April 18-20, 2020 in Ambassador Zlata Husa/Prague.

This conference was supported by European Lefke University and University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca.
"COMMITTEES"

Chairman of the Conference
Dr. M.ATILLA ASKIN (European University of Lefke)

Co-chairman of the Conference
Dr. Otilia Bobis (Romania)

Organization staff of the Conference
Dr. Usha R Patar (Czech University of Life Sciences, Prague)
Dr. Jawad Ali Shah (Czech University of Life Sciences, Prague)
Dr. Shilka Kumari Mehta (Czech University of Life Sciences, Prague)

Scientific Board

- Octavio Paredes-Lopez, Center for Research and Advanced Studies of the National Polytechnic Institute, Mexico, **Mexico**.
- Gulzar Ahmad NAYIK, Sant Longowal Institute of Engineering and Technology, Sangrur, **India**.
- Otilia BOBIS, University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, Cluj, **Romania**.
- Mirela Irina CORDEA, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca Romania
- Adela Ramona MOISE, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca Romania.
- John PICKETT, Rothamsted Research, Harpenden, **United Kingdom**.
- Mohammed Wasim SIDDIQUI, Bihar Agriculture University, Sabour, **India**.
- Faqir Muhammed ANJUM, Vice Chancellor Universityof the Gambia. **Gambia**.
- Khalid Ul Rehman Hakeem, Department of Biological Sciences, Faculty of Science, King Abdulaziz University, Jeddah, **Saudi Arabia**.
- Basharat Nabi DAR, Awantipora, JK, **India**.
- Ashok R. PATEL, International Iberian Nanotechnology Laboratory, **Portugal**.
- Vikas Nanda SLIET, Punjab, **India**.
- M Shafiur RAHMAN, Sultan Qaboos University, **Oman**.
- Muhammad Issa Khan, National Institute of Food Science and Technology, University of Agriculture, Faisalabad. **Pakistan**.
- Milica Fotiric Aksic, University of Belgrade, **Serbia**.
- Agnieszka Barbara Najda, University of Life Sciences in Lublin, **Poland**.
- Nadezhda Traycheva PETKOVA, University Of Food Technology, Plovdiv, **Bulgaria**.
- Imran PASHA, University of Agriculture, Faisalabad, **Pakistan**.
- Shabir Hassan, Harvard Medical School, Massachusetts, **USA**.
- Sezai Ercisli, Atatürk University, Erzurum, **Turkey**.
- Hakan Aktas, Süleyman Demirel University, Isparta, **Turkey**.
- Mevlüt Gül, Süleyman Demirel University, Isparta, **Turkey**.
- Bozena Denisow, University of Life Sciences in Lublin, Lubelskie, **Poland**.
- Atanas Atanasov, Institute of Genetics and Animal Breeding, Warsaw, **Poland**.
- Violeta Nour, University of Craiova, Craiova, Dolj, **Romania**.
- Carlos AlbertoDuqueEcheverri, Universidad de Antioquia, Medellin, **Colombia**.
- Alvaro Luis Morales Aramburo, Universidad de Antioquia, Medellin, **Colombia**.
- Ricardo Leon Restrepo Arango, Universidad EIA, Envigado, **Colombia**.
- Juan Carlos Martinez-Orozco, UniversidadAutónoma de Zacatecas, Zacatecas, **Mexico**.
- Miguel Eduvardo Mora-Ramos, UniversidadAutónoma del Estado de Morelos, Morelos, **Mexico**.
- Tomislav Tosti, University of Belgrade, Belgrade, **Serbia**.
- Halina Buczewska, University of Life Sciences in Lublin, **Poland**.
- Renata Nurzyńska – Wierdak, University of Life Sciences in Lublin, **Poland**.
- Joanna Klepacka, University of Warmia and Mazury in Olsztyn, **Poland**.
- Muhammad Qaiser, Center of Plant Conservation, University of Karachi, Karachi, **Pakistan**.
- Khalid Javed, University of Veterinary & Animal Sciences, Lahore, **Pakistan**.
- Muhammad Abdullah, University of Veterinary & Animal Sciences, Lahore, **Pakistan**.
- Agnieszka Śękara, University of Agriculture in Krakow, Krakow **Poland**.
- Abdurrasoul M. Alomran, King Saud University, Riyadh, **Saudi Arabia**.
- Zeki Mut, Bilecik Şeyh Edebali University, Faculty of Agriculture and Natural Sciences, **Turkey**.
- Dan C. Vodnar, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania.
- Mustafa Türkmen, Giresun University, Giresun, **Turkey**.
- Aysun Türkmen, Giresun University, Giresun, **Turkey**.
MONITORING OF COLOR CHANGES IN DIFFERENT PROCESSES OF ANCHOVY AND SARDINE FILLETS DIPPED IN ORANGE OIL, LEMON OIL AND LIQUID SMOKE

Fikret ÇAKIR, Zayde AYVAZ*

Faculty of Marine Science and Technology, Çanakkale Onsekiz Mart University, 17020 Çanakkale, Turkey.
*Corresponding author email: zaydeayvaz@gmail.com

Abstract
Color is an important sensory attribute to determine the seafood quality by consumers. Computer-based image analysis is an objective, repeatable, and fast method to determine non-homogenized color samples like seafood. Essential oils and liquid smoke are essential to developing seafood color, taste, and shelf-life. In this study, lemon oil, orange oil, and water-based liquid smoke were added in a brine solution of anchovy and sardine fillets. The aim of the study was to determine the effects of lemon oil, orange oil and water based liquid smoke on the color, area and meat yield of anchovy and sardine fillets in raw, after application and after cooking processes. According to results, the area of fillets was significantly changed after cooking for all groups (p<0.05). The a* value of lemon oil group of anchovy was 4.56±0.25, 53.90±0.67, and 61.77±0.75 during raw, after salting and application, after cooking, respectively. The same value for sardine was changed 6.15±0.49, 3.90±0.48, and -1.26±0.24 during raw, after salting and application, after cooking, respectively. The a* value of lemon oil, orange oil, and liquid smoked anchovy and sardine groups were significantly changed after brine solution applications and cooking (p<0.05). However, the importance of L*, b*, Chroma and Whiteness values of lemon and orange oil groups of anchovy and sardine fillets increased only after cooking. The meat yield values were 52.02, 48.73 and 49.95 for lemon, orange oil and liquid smoked anchovy fillets, respectively. The meat yield of sardine fillets were 68.73, 64.49 and 55.18 for lemon, orange oil, and liquid smoked fillets, respectively. Results were shown that adding liquid smoke to brine solution has always created differences that are more pronounced over the color characters than the lemon and orange oil applications in each application for anchovy and sardine fillets. Cooking has a significant impact on the areas of anchovy and sardine fillets. The salting effect changed the meat yield. It was found that the meat yields of liquid smoked products were lower than the other groups.

Keywords: Color, orange oil, lemon oil, liquid smoke, consumer preference.

INTRODUCTION
Color improvement of food with food additives have been widely used by the industry. The use of synthetic color development agents is losing popularity because of increasing consumer awareness. The plant oils are accepted as green chemicals (Rahman, 2007). Their effects are not only on color but also they provide longer shelf life especially in seafood (Alçiçek, 2011; Mayeli, Mehdizadeh, Tajik, Esmaili, & Langroodi, 2019). The pigments of the plant oils can react more or less depends on plant and food products properties (Bohra, Waman, Roy, & Shivashankara, 2019; Diehl, 2008). The oils of carotenoid-containing plants such as lemons and oranges can be easily applied to seafood (Mayeli et al., 2019; Yildiz Oguzhan, 2019).

Smoke flavoring usage for seafood has been using the last four decades (Varlet, Serot, & Prost, 2010). The smoke flavors have complex compounds. One of them is phenolic compounds and they directly affect the color of the applied food surface and give brown/yellow color, which is the characteristic color of smoked foods (Ayvaz, Çakır, Gündüz, & Erdağ, 2017; Varlet et al., 2010).

Smoke flavoring usage for seafood has been using the last four decades (Varlet, Serot, & Prost, 2010). The smoke flavors have complex compounds. One of them is phenolic compounds and they directly affect the color of the applied food surface and give brown/yellow color, which is the characteristic color of smoked foods (Ayvaz, Çakır, Gündüz, & Erdağ, 2017; Varlet et al., 2010).

Color analyze is important to determine the color of a food product. It can be determined by food experts. However, individual perception differences highly affect the color determination results. Thus, there is instrumental equipment for analyzing color. However, some researchers have argued that this equipment does not always have accurate results on the seafood surface due to the nonhomogeneous color distribution (Balaban, Aparicio, Zotarelli, &
Sims, 2008; Oliveira & Balaban, 2006; Ünal Şengör et al., 2018). For eliminate the problems, the computer-based image analyses systems have been used for the last four decades (Ayyaz, Balaban, & Kong, 2017; Balaban et al., 2008).

This study aimed to determine the effectiveness of lemon, orange oils and water-based smoke flavoring on the anchovy and sardine fillets by using computer-based image analysis.

MATERIALS AND METHODS

Fresh anchovy and sardine samples were obtained from a local fish market in Canakkale-Turkey on March 2019. They were gutted, de-headed and washed with tap water in the laboratory. After filleting process, the samples were divided into four groups for each fish species as lemon oil, orange oil, and liquid smoke flavoring (LS) groups. The colorants added in a brine solution (4% commercial salt) for every group. the fish samples dipped in the solutions (1:1 w/v) for 2 hours at 4°C. Then, the samples drained at the room temperature. They cooked at 120°C for 8 minutes in a fan oven after draining. All samples pictures were taken by a Nikon D300 camera (Nikon Co., Tokyo, Japan) in a light-box, which described by Alçıçek & Balaban, (2012) and Luzuriaga, Balaban, Hasan, & Teixeira, (1997) to determine the area (cm²) and color parameters (L*, a*, b*, Chroma, and Whiteness) of samples at every step of the process: initial, after salting and application, and after cooking. Besides, the weight of the samples was recorded to determine the meat yield. A software (SPSS v.23, IBM, IL, US) used to carry out the statistical analysis. Data were subjected to analysis of variance (one-way ANOVA). Results were reported as mean values ± standard error. The Tukey post-hoc test was used to show the difference between groups at the alpha level 95% (p<0.05).

RESULTS AND DISCUSSION

Table 1 shows the area and color parameters’ changes of anchovy and sardine samples during process steps.

The $L^*$ value of the initial anchovy fillets were 53.65±0.72, 53.81±0.44, and 53.90±0.78 for lemon, orange oil, and LS groups, respectively. After salting and application process, this values slightly increased for all groups, but this increase was not found statistically significant ($p>0.05$). The expectation was that the LS application would turn dark the color of the fillet. The results showed that the brining suppressed the LS effect and the color went to lighter. However, the $L^*$ value of the samples dramatically changed after cooking and the LS group showed the expected results. The same trend was observed for Whiteness value. The $L^*$ value of the anchovy samples were 61.77±0.75, 60.61±0.50, and 36.83±1.05 for lemon, orange oil, and LS groups in the after cooking process step, respectively. There was no statistical significance between lemon and orange oil groups ($p>0.05$), but the LS group had statistical significance from the other groups ($p<0.05$). This is probably because of the high-temperature occurrence during cooking and this provided water lost and changed in the muscle structure. Besides, the LS gave a dark color due to reduced moisture the phenolic compounds had an effect on the structure of the fillets (Alçıçek & Balaban, 2015; Varlet et al., 2010). Same effects were followed for the other color parameters. The $a^*$ value of the anchovy samples were decreased even after brining and application process. This decrease was found statistically significant than initial $a^*$ value of the samples ($p<0.05$). On the other hand, the LS group showed statistical significance from the other two groups on the after brining and application process step ($p<0.05$). This is due to phenolic compounds of LS applied. When samples cooked at high temperature, the $a^*$ value of the oil applied groups decreased, the $a^*$ value of LS group increased due to combining effects of phenolic compounds and cooking temperature. The $a^*$ value of the cooked samples was found statistically significant both in the group and between the groups ($p<0.05$). The $b^*$ value of the anchovy samples increased after brining and application stage. This increase was found statistically significant for the LS group ($p<0.05$), but was not for the oil applied groups ($p>0.05$). This result showed that the LS application has a significant effect on the $b^*$ value of anchovy fillets. Besides, cooked fillets of the LS group’s $b^*$ value did not show any significant difference from the latter process step ($p>0.05$). This clearly confirms that cooking does not significantly change the $b^*$ value of the LS applied anchovy samples. The $b^*$ value of the lemon oil applied group stayed nearly the same value with initial in the after brining and application step ($p>0.05$). However, the orange oil added group’s $b^*$ value was monitored as significantly increased in the same process step, but this increase did not show any statistical significance also ($p>0.05$). This is probably due to the carotenoid levels of orange oil (Guimarães et al., 2010). The same trend was observed Chroma values for all groups. When the sardine samples color parameters were observed, there was no different finding from the trend of anchovy samples. This is clearly showed that the application process affected both of fish species in the same way.

The meat yield values were 52.02%, 48.73% and 49.9% for lemon, orange oil and liquid smoked of anchovy fillets, respectively. The meat yield of sardine fillets were 68.73%, 64.49% and 55.18% for lemon, orange oil, and liquid smoked fillets, respectively. The area values dramatically decreased after cooking for all groups.

Results were shown that adding liquid smoke to brine solution has always created differences that are more pronounced over the color characters than the lemon and orange oil applications for anchovy and sardine fillets. Cooking has a significant impact on the areas of anchovy and sardine fillets. The salting step changed the meat yield. It was found that the meat yields of liquid smoked products were lower than the other groups except orange oil applied anchovy group.
Table 1: The area and color parameters of anchovy and sardine fillets during process steps.

<table>
<thead>
<tr>
<th>Application</th>
<th>Lemon Oil</th>
<th>Orange Oil</th>
<th>Liquid Smoke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchovy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape and Color Values</td>
<td>Raw</td>
<td>After Brining and Applications</td>
<td>After Cooking</td>
</tr>
<tr>
<td>Area</td>
<td>14.66±0.50&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>15.53±0.48&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>10.15±0.29&lt;sup&gt;Ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>L*</td>
<td>53.65±0.72&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>53.90±0.67&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>61.77±0.75&lt;sup&gt;Ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>a*</td>
<td>4.56±0.25&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>2.58±0.22&lt;sup&gt;Ab&lt;/sup&gt;</td>
<td>-0.38±0.23&lt;sup&gt;Ac&lt;/sup&gt;</td>
</tr>
<tr>
<td>b*</td>
<td>6.9±0.77&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>6.84±0.63&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>13.07±0.71&lt;sup&gt;Ac&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chroma</td>
<td>10.95±0.47&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>10.32±0.39&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>14.91±0.66&lt;sup&gt;Ab&lt;/sup&gt;</td>
</tr>
<tr>
<td>Whiteness</td>
<td>51.79±0.71&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>52.18±0.69&lt;sup&gt;Aa&lt;/sup&gt;</td>
<td>58.39±0.84&lt;sup&gt;Ab&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

| Sardine     |           |            |              |
| Shape and Color Values | Raw | After Brining and Applications | After Cooking | Raw | After Brining and Applications | After Cooking | Raw | After Brining and Applications | After Cooking |
| Area        | 27.77±1.87<sup>Aa</sup> | 29.94±1.94<sup>Aa</sup> | 19.28±1.47<sup>Ab</sup> | 28.47±1.59<sup>Aa</sup> | 29.97±1.55<sup>Aa</sup> | 19.02±1.88<sup>Ab</sup> | 27.47±1.75<sup>Aa</sup> | 28.38±1.85<sup>Aa</sup> | 16.94±1.46<sup>Bb</sup> |
| L*          | 55.17±0.84<sup>Aa</sup> | 55.38±0.84<sup>Aa</sup> | 67.70±0.79<sup>Ab</sup> | 55.98±0.36<sup>Aa</sup> | 56.62±0.36<sup>Ab</sup> | 66.49±0.57<sup>Ab</sup> | 56.53±0.73<sup>Ab</sup> | 56.57±0.63<sup>Ab</sup> | 42.75±3.96<sup>Bb</sup> |
| a*          | 6.15±0.49<sup>Aa</sup> | 3.90±0.48<sup>Ab</sup> | -1.26±0.24<sup>Ac</sup> | 6.34±0.56<sup>Aa</sup> | 3.92±0.51<sup>Ab</sup> | -1.47±0.25<sup>Ac</sup> | 5.77±0.61<sup>Ab</sup> | 2.08±0.53<sup>Ba</sup> | 9.33±1.91<sup>Bb</sup> |
| b*          | -0.12±0.79<sup>Aa</sup> | -0.31±0.92<sup>Aa</sup> | 6.70±0.54<sup>Ab</sup> | -0.58±0.58<sup>Ab</sup> | 2.06±0.84<sup>Ab</sup> | 4.81±0.48<sup>Ac</sup> | 0.84±0.61<sup>Ab</sup> | 13.23±0.68<sup>Bb</sup> | 13.89±1.70<sup>Bb</sup> |
| Chroma      | 10.33±0.39<sup>Aa</sup> | 9.46±0.38<sup>Aa</sup> | 9.61±0.41<sup>Ab</sup> | 10.27±0.26<sup>Aa</sup> | 9.58±0.24<sup>Ab</sup> | 9.26±0.33<sup>Ab</sup> | 10.01±0.26<sup>Aa</sup> | 14.81±0.59<sup>Bb</sup> | 18.92±1.72<sup>Bc</sup> |
| Whiteness   | 53.73±0.91<sup>Aa</sup> | 54.15±0.90<sup>Aa</sup> | 65.86±0.88<sup>Ab</sup> | 55.18±0.39<sup>Aa</sup> | 54.66±0.38<sup>Ab</sup> | 64.75±0.59<sup>Ab</sup> | 55.10±1.99<sup>Ab</sup> | 53.46±0.73<sup>Aa</sup> | 39.12±4.26<sup>Bb</sup> |

*Different capital letters show the difference between the different group, the same process step and the same parameters, different small letters show the difference between the same group, the same parameter and different process steps (p<0.05).
REFERENCES


