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Determination of Some Quality Changes of Sous Vide-Sea Bass Fillets (*Dicentrarchus labrax*, Linnaeus, 1758) Treated with Dried Basil, Fresh Garlic, and Dill Weed

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Research Article

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Abstract

Dried basil (0.5%), fresh garlic (0.25%), and dill weed (0.5%) were added onto fish fillets and then this combination was cooked by using sous vide technique. Total volatile basic nitrogen (TVBN), pH, sensory and color (L*, a*, and b*) measurement analysis were performed in order to reveal the quality differences. TVBN results revealed that the use of dried "basil, fresh garlic, and dill weed could delay the rapid deterioration in the chemical quality of fish fillets cooked by sous vide technique. The used herbs successfully preserved the sensory quality of the fish samples cooked by sous vide technique as well. Sensory and physicochemical quality assurance tests demonstrated that combination of dried basil and fresh garlic with sous vide cooking technique were effective against deterioration. The sea bass fillets that were treated with dried basil, fresh garlic, dill weed and cooked at 65°C for 20 minutes had the shelf life up to 42 days.

Keywords: Sous vide, sea bass quality, dried basil, fresh garlic, fresh dill weed.

Kurutulmuş Fesleğen, Taze Sarımsak ve Dereotu ile Muamele Edilen Sous Vide Levrek (*Dicentrarchus labrax*, Linnaeus, 1758)Filetolarının Bazı Kalite Değişimlerinin Değerlendirilmesi

Özet

Kurutulmuş fesleğen (%0,5), taze sarımsak (%0,25) ve dere otu (%0,5) balık filetolarının üzerine eklenmiş, ardından bu kombinasyon sous vide tekniği ile pişirilmiş ve örnekler 3ºC' de depolanmıştır. Toplam uçucu bazik azot (TVBN), pH, duyusal ve renk ölçüm analizleri, kalite farklılıklarını ortaya koymak için gerçekleştirilmiştir. TVBN sonuçları kurutulmuş fesleğen, taze sarımsak ve dereotu kullanımının sous vide tekniği ile pişirilen balıklardaki kimyasal kalite bozulmasını geciktirebileceğini ortaya koymuştur. Ayrıca bu kombinasyon duyusal bozulmayı da başarılı bir şekilde geciktirmiştir. Duyusal ve fizikokimyasal kalite testleri sous vide pişirme tekniği ile taze sarımsak, kurutulmuş fesleğen kombinasyonunun bozulmaya karşı etkili olduğunu ortaya koymuştur. Taze sarımsak, kurutulmuş fesleğen ve taze dereotu ile muamele edilen ve 65ºC de 20 dakika süresince pişirilen levrek balığı filetolarının 42 gün raf ömrüne sahip olduğu tespit edilmiştir.

Anahtar kelimeler: Sous vide, levrek kalite ,kuru fesleğen, taze sarımsak, taze dereotu.

INTRODUCTION

Fish is an important part of a well-balanced diet because of the fact that it includes important nutrients such as vitamin, mineral, fatty acid, amino acid (Larsen et al., 2011). Moreover, consumption of seafood plays a key role to decrease the potential cardiovascular, diabetes, alzheimer, psychological disease risks (Valenzuela and Valenzuela, 2013). Although seafood has many benefits for human health, it is easily perishable food as well. Therefore, cooling, freezing, irradiation, food additives, different pasteurization methods, smoking, salting, drying are usually applied to prolong the shelf life of seafood. Furthermore, the combination of different preservation techniques has widely been utilized for seafood. Because of these reasons, microbial spoilage, chemical and physical deterioration, sensory changes of fish samples have been able to be controlled during cold storage (Fellow, 2000; Placek 2004; Ghaly et al., 2010).

In this respect, the sous vide cooking technique is applied under controlled temperature (between 65 and 95°C) and a certain time (between 5 and 60 min.). Hence, cold storage conditions, type of food, cooking time and rapidly cooling are defined to be important parameters for this process (Meng and Genigeorgis, 1994; Schellekens, 1996; Gonzales-Fandos et al., 2005; Espinosa, 2015).

Being minimally processed by sous vide technique is the most important advantage for the fish products (Picouet et al., 2011; Çetinkaya, 2013). Sous vide cooking technique provides better protection in terms of sensory quality for seafood than conventional cooking methods. Because, the rapid occurrence of volatile bases and fishy aroma materials in seafood can be delayed by using sous vide technology (Baird, 1990; Church and Parsons, 2000). In this sense, the shelf life of products cooked by the sous vide technique, is mostly defined to be between 6 and 45 days. Previous study results reveal that food type, cooking time and temperature, combination methods may play a key role to determine the shelf life (Schellekens, 1996; Gonzales-Fandos et al., 2005; Picouet et al., 2011; Espinosa, 2015). In terms of the consumer, using natural or organic food additives as a food preservative is preferred (Ceylan and Sengör, 2014). In this regard, sage, garlic, dill weed, basil, thyme, rosemary, oregano and their oils may have an inhibitory effect against bacteria and they may act a role for the prolong the shelf life of fish(Çakır et al., 2011; Hassanian and El-Daly, 2013; Angiolillo et al., 2014; Frank et al., 2014). Thusly, in time, the use amount of natural extracts or materials can increase instead of using chemical preservatives. Sous vide cooking technique is widely used for, especially, most of the foodstuff, unfortunately, adequate studies have not been conducted on fish quality. On the other hand, the most of the present studies are related to the quality of salmon and rainbow trout cooked with the sous vide technique. In addition, it is widely known that sea bass distributed from Baltic Sea to the Black Sea has an important economic potential for the fish farming industry in Turkey, Greece and also Spain (Alpbaz, 1990; Uçal and Benli, 1993; Kaya, 2006).These fish species are mostly consumed as fresh, but ready-to-eat process providing higher quality can play a key role to increase the consumption ratio of the fish species. TVBN and pH analysis determine the quality of seafood. Furthermore, TVBN value is correlated with bacterial growth. In this respect, when bacteria count increases, TVBN value mostly increases (Tingman et al., 2010; Jinadasa, 2014). In addition to pH and TVBN, the sensory analysis including odor, texture, taste and appearance parameters are evaluated to be one of the most important analysis to determine the stability of seafood (Tejada et al., 2006). Also, L*, a*, and b* values are usually used to prove the physical quality changes (Gerdes and Santos, 1991).

The primary goal of the present work was to investigate the combined effects of herbs and sous vide cooking technique on the shelf life of fish. For this aim, fresh garlic, fresh dill weed, and dried basil were added onto the fish fillets and then TVBN, pH, color and sensory analysis of the fish samples stored at refrigerator conditions were performed during the cold storage period. Also the quality differences was to determine between the control group fish samples and treated with different herbs fish samples.

MATERIAL and METHODS

Material

Fresh sea bass samples (*Dicentrarchus labrax*; Linnaeus, 1758) having high quality were filleted (n:3 for each group and analysis day). Dried basil, fresh garlic, and fresh dill weed were obtained from local market. Filleted fish and the herbs were put in smooth plastic pouches, which had 160 oxygen transmission rate (OTR) $cm^3/m^2/24h$. All cooked samples were kept in the dark, cold storage condition in a refrigerated chamber at a temperature of 3°C during the rest of the experiment.

Preparation of Group C Fillets (Control)

Sea bass fillets (100±4.84 g) were cooked at 65°C for 20 min in thermostatically controlled water baths. Polyscience, Sous Vide Professional Chef Series Cooking Kit (Niles USA) was used to cook the fillets with controlled temperature and time. As soon as the samples were cooked, they were chilled by iced water until 3.3°C in less than 10 min. After chilling, all samples were stored in cold (at 3°C) during the shelf-life period.

Preparation of Group FS Fillets (Dried Basil and Garlic)

Dried basil (0.5%) and garlic (0.25%) were added to fish fillets (100±4.84 g) before sealing the pouches, and then the samples were packaged to be vacuum and cooked at 65°C for 20 min by using sous vide technique.

Preparation of Group FSD Fillets (Dried Basil and Garlic and Dill Weed)

After adding dried basil (0.5%), garlic (0.25%) and fresh dill weed (0.5%) into boilable pouches, which included fish fillets, they were sealed under vacuum and cooked at 65°C for 20 min with sous vide technique.

Analysis Methods

Sensory analysis was carried out with ten trained panelists for each group. Other analyses were measured in triplicate during each of period in the study.

Sensory Analysis

The sensory qualities of the sous vide sea bass fillets were evaluated using 0-10 scores according to modified Regenstein and Regenstein (1991). <5 was defined to be unacceptable for human consumption. The appearance, odor, texture, taste, and color of sous vide fish fillets were evaluated by trained panelists. Fish fillets were coded with different symbols as C, FS and FSD which is group codes were evaluated separately by each trained panelist. Three packs from each group were chosen and evaluated randomly for sensory analysis by the trained panelists (n=10).

Chemical Analysis

The method reported by Schormüller (1968) was used to determine the TVBN values of fish samples. 10g of a homogenized sample of fish muscle was suspended in 250 ml of pure water, made alkaline with 1-2 g of MgO and distilled. The rate of heating was adjusted so that the suspension reached the boiling point in 10 minutes and distillation was performed for 20 minutes. Then, the distillate was titrated with 0.1N NaOH. The results were reported as mg TVBN/100 g fish muscle.

pH Measurement

pH values of fish flesh in water (1:10 v/w) were measured by Thermo Scientific Model Orion Star A 214 (Beverly, MA, U.S.A) pH meter, after calibration. 2-homogenized sea bass sample of each group (C, FS, and FSD) was stirred with 20 ml of distilled water (v:w; 1:10). The pH electrode was dipped into the stirred solution and the value was recorded (Manthey et al., 1988).

Color Measurement

The color measurement was determined by using the Minolta colorimeter (Model CR-400, Japan) during cold storage. L*, a*, b* values were measured in triplicate from different points of each group. In the CIELab system, L* value represents lightness from black to white between 0 and 100; a* value represents from (+) red to (-) green; and b* value represents from (+) yellow to (-) blue (Nakano et al. 2018).

Statistical Analysis

Collected data were subjected to analysis of variance (ANOVA) to evaluate the deterioration of fish fillets called as C, FS, and FSD during experimental days. GraphPad Prism software (California corporation, USA) was used to determine significant differences between groups by ANOVA. When a significant ($p<0.05$) main effect was found, mean values were further analyzed using the Duncan's Multiple Range Test comparison test.

RESULTS and DISCUSSIONS

Sensory Evaluation

The results had from the sensory analysis are indicated in Fig 1. Odor, texture, taste, color characteristics of all group samples were evaluated as part of the average sensory score.

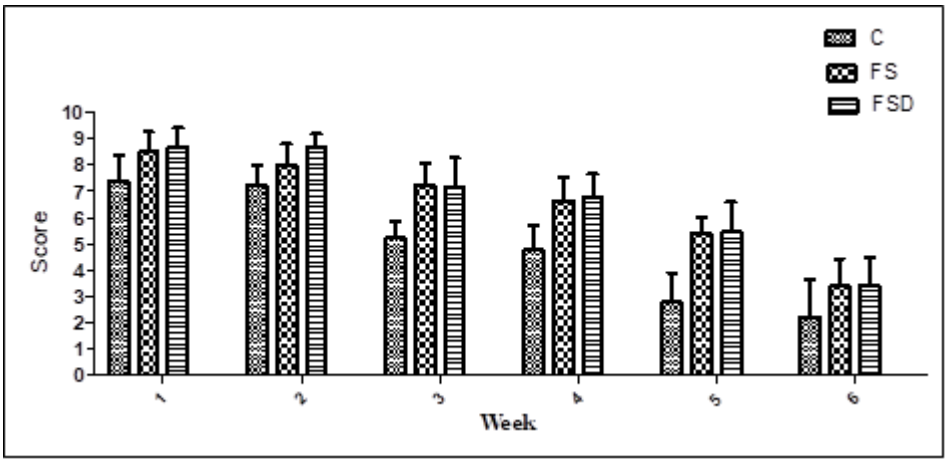

Figure 1. Average sensory score of sea bass fillets during cold storage period (n = 10).

FSD had the highest sensory quality with 8.89 score in the first week, on the other hand, C could receive 7.42 score. The sensory score of FSD and FS were found to be higher than that of C during cold storage. In the 5th week, FS was still considered as acceptable for human consumption with 5.40 average sensory score, even though it had lower average sensory score than that of FSD. Yet, between two groups, statistical differences ($p>0.05$) were not found. Fresh dill weed helped to obtain better color, taste, and odor on fish samples cooked with sous vide technique as compared to the control group samples. While FS and FSD were able to reach the sensory limit value at the 42nd day of the cold storage, control group samples already exceeded the sensory limit value at the 28th day of the cold storage period. Cooking at 65°C for 20 minutes provided better quality for FS and FSD samples, since the herbs may have been prevented the rapid loss of water from fish samples. Thus, the herbs may have been improved the general acceptability of sous vide sea bass fillet.

Rancidity, putridity, and discoloration were determined in the fourth week of cold storage in general evaluation of C samples. In this respect, C was determined to be unfit for human consumption at the 28th day of cold storage, while FS and FSD were determined to be fit for human consumption up to 42nd days. There were statistical differences between C and FS/FSD ($p<0.05$). Previous studies revealed that foodstuff cooked with sous vide technique might have longer shelf life than 45 days depending on cooking time and temperature (Fandos et al., 2004). Also, Fandos et al. (2005) and Diaz et al. (2009) reported that the shelf life of sous vide cooked salmon sample was 21 and 18 days, respectively. Furthermore, a combination of sous vide cooking technique with another food preservation technique might provide a longer shelf life (Ceylan and Sengör, 2017). In this sense, Piscouet et al. (2011) reported that high-pressure application on salmon extended the shelf life up to six days. Also, Çetinkaya (2013) noted that linseed and some natural antioxidants could keep the sensory quality of fish species cooked with the sous vide technique. Moreover, Benkeblia (2004) revealed that garlic, which could have higher antibacterial activity in case of being heated, would have highly powerful antibacterial effect against bacteria and fungus and be used as natural food additive. Cooking of garlic at 65°C for 20 minutes could have increased the antibacterial effect, in our study. Pakawatchai et al. (2009) stated that garlic and basil had the antimicrobial effect on minced salmon. In other studies, sous vide cooked foods, containing herbs, spices, and sauces, could have a better sensory stability (Schafheitle, 1990). Previous studies have correlated with our study results, in this respect, the use of herbs with the sous vide technique delayed clearly the rapid sensory deterioration. Also, due to the fact that vacuum packaging application in sous vide technique prevents the loss of aroma components that give flavor to fish, a better sensory quality is able to be obtained.

TVBN

The results obtained from the TVBN analysis are indicated in Fig 2. In the present study, the TVBN value of raw sea bass was determined as 17.21 mg/100g that the samples were classified to be of high quality. TVBN value of all groups increased along cold storage period. On the other hand, in the first week of cold storage, C, FS, and FSD reached 21.2 mg/100g, 20.79 mg/100g, 20.52 mg/100g

TVBN value, respectively. TVBN value of C group samples was found to be 28.26 mg/100g when the samples were determined to be unfit for human consumption according to the sensory analysis results.

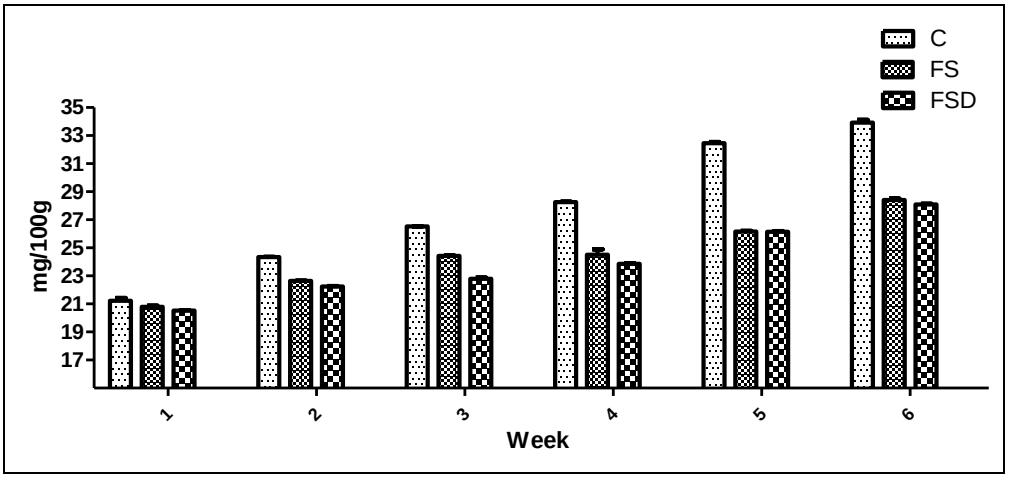

Figure 2.TVBN changes of sea bass fillets during cold storage period (n = 3).

In this respect, TVBN value in the previous studies is classified to be 25 mg/100g showing high quality, and 30 mg/100g defining the good quality. However, the value above 35 mg/100g is accepted as the limit value for fish and fish products (Huss, 1995; Boran and Sevim, 2007; European-Commision, 2008). In our study, 28 mg/100g TVBN value is accepted to be limit value in terms of determination chemical quality. As known, TVBN, which can be used as an important indicator for raw and preserved or lightly preserved seafood, increases because of bacterial growth, this situation effects sensory characteristics and physicochemical properties of seafood (Zhong-Yi et al., 2010; Amegovu et al., 2012).

The addition of dill weed to dried basil and garlic was not limited the chemical deterioration of the fish samples ($p>0.05$) when compared to FS samples. On the contrary, the addition of dried basil, garlic and dill weed to sous vide cooked sea bass samples delayed the prominently increase of TVBN value ($p<0.05$). C, FS, and FSD samples reached 28.26 mg/100g (in the fourth week), 28.41 mg/100g (in the sixth week) and 28.09 mg/100g TVBN values (in the sixth week), respectively. These values were accepted as a limit value in terms of TVBN for all groups, which already exceeded into the sensory limit score. Dalgaard (2000) reported that cod fish fillets cooked with sous vide technique and stored at 3°C had 21-days shelf life. In addition, carp fillets cooked at 90°C along 15 min and stored at 2°C could reach 25 mg/100g TVBN value at the end of the shelf life. On the other hand, the TVBN value of yellow tuna fish fillet stored at 4°C was determined to be 34.32 mg/100g at the end of the shelf life (Jinadasa et al., 2015).

The above-mentioned studies revealed that fish fillets cooked with sous vide technique could have lower TVBN value as compared to the fish fillets treated with other preservation or processing method. In this respect, in our study, FSD and FS successfully delayed the deterioration in the chemical quality of fish fillets as compared control group fish samples.

pH

Figure 3 indicates pH results at a different time for all groups along 6 weeks of storage at 3°C. pH is one of the most significant analysis to reveal seafood freshness rapidly. pH value in the fresh seafood change depending on fish species (Şengör et al., 2000). However, pH values of fresh fish are mostly defined between 6.0 and 6.8. pH value of fresh tunas is under 6.0 because of the high glycogen concentrations (Howgate, 2009). In our study, the pH value of raw sea bass was found to be 6.62. Using dried basil, garlic and dill weed influenced the pH values of FS and FSD group during the analysis period. In this regard, statistical differences were found between C and FSD ($p<0.05$). The values in FS and FSD groups were below the acceptable pH value until the sixth week of the cold storage. On the other hand, the pH value of the control group sample already exceeded into limit value in the third week of the cold storage period. On the week of sensory rejection was observed, C, FS, and FSD group had 6.85, 6.81 and 6.82 pH values, respectively.

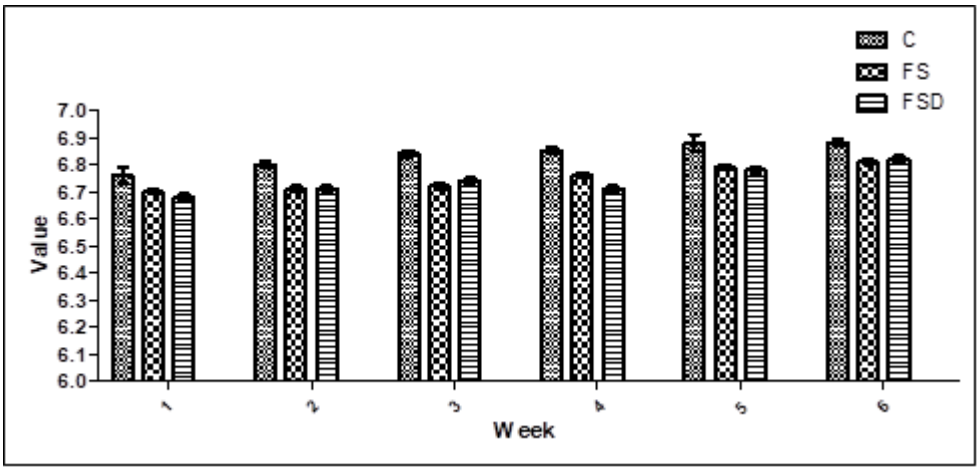

Figure 3.pH changes of sea bass fillets during cold storage period (n = 3).

Increase in pH value of C was more rapidly as compared to that of FS and FSD during cold storage condition. However, fresh dill weed did not delay the deterioration in pH value of fish fillets called FSD ($p>0.05$). On the contrary, the addition of dried basil and garlic to sous vide sea bass fillets affected pH values between C and FS group ($p<0.05$). Espinosa et al. (2015) reported that using the sauce in sous vide processing can affect the pH values of fish samples cooked with sous vide technique. Moreover, the study noted that some sauces play a key role to keep under control microbiological load of sous vide fish. In this respect, Shakila et al.(2009), reported that using herbals in sous vide fish provides lower increase in pH. During cold storage of sous vide fish samples, the pH values of C, FS, and FSD groups increased 3.5%, 2.9%, and 3%, respectively. In the present study, sensory analyses results were correlated with the increase in pH value and also pH values of all fish groups increased by storage period, but C group reached into the highest value of all during cold storage period at 3°C.

Color Measurement

L*, a*, b* values were measured to follow the color changes of all samples that were cooked as sous vide technique and combined with different herbs. Decreasing the brightness L* from 80.38 to 78.18 for C, from 79.56 to 77.84 for FS and from 85.84 to 82.69 for FSD groups samples were determined as group C samples were evaluated as spoilt according to sensory analyses results (Table 1, 2 and 3).

Table 1. L* values of sea bass fillets during cold storage period (n = 3).

L*	**C**	**FS**	**FSD**
Week			
1	80.38 ± 0.19^{a}	79.56 ± 0.04^{a}	85.84 ± 0.12^{b}
2	79.92 ± 1.05^{ab}	74.63 ± 0.55^{a}	82.88 ± 0.39^{b}
3	79.73 ± 1.03^{a}	76.19 ± 0.09^{b}	84.35 ± 1.82^{c}
4	78.18 ± 1.23^{a}	77.84 ± 1.35^{a}	82.69 ± 1.56^{a}
5	68.21 ± 2.16^{a}	74.61 ± 0.74^{a}	77.79 ± 0.41^{a}
6	69.40 ± 2.15^{a}	66.36 ± 0.33^{a}	72.02 ± 1.05^{a}

Table 2. a* values of sea bass fillets during cold storage period (n = 3).

a*	C	FS	FSD
Week			
1	1.27±0.21^{a}	-0.72±0.06^{b}	-0.48±0.12^{bc}
2	0.11±0.01^{a}	0.73±0.15^{a}	-2.04±0.12^{b}
3	0.71±0.05^{a}	-0.18±0.06^{b}	-2.12±0.41^{c}
4	0.72±0.15^{a}	0.19±0.05^{a}	0.22±0.05^{a}
5	4.26±1.21^{a}	-0.76±0.02^{b}	-0.11±0.07^{bc}
6	1.71±0.22^{a}	1.45±0.32^{a}	1.25±0.31^{a}

Table 3. b* values of sea bass fillets during cold storage period (n = 3).

b*	C	FS	FSD
Week			
1	9.45±0.36^{a}	10.84±0.39^{a}	11.39±0.45^{a}
2	12.79±1.06^{a}	11.81±0.04^{a}	9.75±0.51^{b}
3	12.25±1.11^{a}	9.29±0.09^{b}	10.88±0.67^{c}
4	14.72±0.24^{a}	10.01±0.81^{b}	12.64±1.05^{c}
5	16.05±0.12^{a}	13.84±0.21^{ab}	12.83±0.41^{b}
6	13.14±0.14^{a}	22.69±0.16^{bc}	22.13±0.44^{c}

Different letters (^{a}, ^{b}, and ^{c}) define $p<0.05$ (Statistical differences).

Also, a* (redness) values of FS and FSD fillets increased from -0.72 to 0.19 and from -0.48 to 0.22, that of C samples decreased from 1.27 to 0.72. b* value of group C increased rapidly as compared to FS and FSD samples. As known, increase in b* value of fish meat is related to oxidation in fish meat (Sohn et al., 2005). In this sense, the study revealed that using dried basil, fresh garlic and dill weed might retard the oxidation of FS and FSD. Statistically differences were found for b* values of all groups ($p<0.05$). a* and b* values of FS and FSD were found to be more stable during the 28 days. As well known that color stability is important for consumer preferences. Also, the changes in b* value can be associated with the oxidation. In this respect, revealing that the initial color quality of FS and FDS groups was more successfully preserved as compared to control group samples. Piscouet et al. (2011) reported that combination of sous vide cooked salmon fillets with high-pressure treatment increased initial L*, a* and b* values from 50.9, 14.8, 18.1 to 60.7, 16.9, 21.1, respectively. Also, no statistical difference was detected ($p>0.05$). As known, the color of fillets can change depending on fish species. As stated by Ceylan (2014) initial L*, a* and b* values of sea bass sealed in pouches decreased by time. It is clearly understood that differences in fish species and preservation techniques may play a key role. In the present study, the changes in L*, a*, and b* values have been associated with a rise in TVBN, pH values and decreasing of sensory scores in all parameters during cold storage period at 3°C.

CONCLUSION

Fish fillets, which included dried basil (0.5%), fresh garlic (0.25%) and dill weed (0.5%) and then cooked with sous vide technique, were found to have a lower TVBN and pH value as compared with C fish samples. Sensory test results indicated that sensory decomposition of fish fillets would be controlled using dried basil, fresh garlic and dill weed. Also, this study revealed that color changes in L*, a*, and b* of FS and FSD during storage period could be controlled. The shelf life of control group samples was defined to be 28 day, on the other hand, FS and FSD samples could be found to be fit for consuming up to the 42nd day of the cold storage conditions (at 4ºC). In this sense, the results suggested that cooking at 65°C for 20 minutes of the fish fillets with dried basil, fresh garlic and dill weed could be an effective and easy method, which could serve ready-to-eat sector to keep some quality parameters in fish fillets.

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