The Effect of Freshness on Meat Color and Chemical Composition of European Anchovy, *Engraulis encrasicolus*, caught by Purse Seine in the Black Sea

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***Abstract*—** The present study was conducted to evaluate of effects of freshness on chemical composition and whole body color of the European anchovy, Engraulis encrasicolus, caught by purse seine between November and December in the Black Sea, Turkey. Freshness of fish were divided in four freshness groups (F1, F2, F3, F4) as beginning of processing time (12 h, 24 h, 36 h and 70 h) after catch. Proximate analyzes were also performed for each groups. The TVB-N values (mgN/100 g) of F1, F2, F3, and F4 groups were determined as 23.9±0.33, 43.5±0.75, 60.7±1.74 and 96.3± 6.40, respectively (one-way ANOVA, P = 2.729E-14). The color of fish were divided in three groups by colors of the homogenized whole fish body. Color-a (redness of fish meat) did not effected by freshness of meat (P = 0.07499), but color-b (yellowness of fish meat) (P = 0.000123) and color-l (lightness of meat) (P = 9.601E-09) effected by freshness of whole body. Dry matter of the groups were significantly different between only F1 (33.4±0.21%) and F2 (31.3±0.48%) groups (P = 0.02767), and also crude lipid values significantly different between F1(13.4±0.00%) and F2 (11.9±0.38%) (P = 0.01126), and between F1 and F4 (12.0±0.17%) (P = 0.02048). However, crude ash (P = 0.4984) and crude protein (P = 0.4746) values among the groups were not significantly different (P < 0.05).

***Keywords*—**European anchovy, *Engraulis encrasicolus*, proximate composition, freshness, color.

I. Introduction

EUROPEAN anchovy, *Engraulis encrasicolus*, is one of the most important fish species of the Mediterranean basin including Black sea. In Turkey for last decades, the average annual catch of E. *encrasicolus* is 280.679± 23.295 tons (between 138.569-385.000 tons), which constitute about 68.8% of the total marine fisheries production of Turkey [1]. E. *encrasicolus* is caught in the Black sea with purse seine between 15 November–15 December. Purse seine and mid-water trawl are two commercial important coastal pelagic species fishing vessels in the Black Sea. Legal anchovy fisheries with mid-water trawl towed behind two boats (pair trawling) are conducted only in Samsun region in Turkey. Together with, the purse seine is used commercially for anchovy fisheries all over the Black Sea and others sea in Turkey [1]-[2].

Almost half of the fished anchovy in Turkish seas is processed at fishmeal factories in the Black Sea region of Turkey [3]. Fish species such as *E. encrasicolus and Sprattus sprattus*, which cannot be processed daily during the intensive fishing time, can be waited generally for 2 and 3 days due to different reasons e.g. processing capacity of the fishmeal factory [4]-[5]. Beginning of processing time after catch of fish species in the fishmeal factory is one of the crucial factors in respect to fishmeal and oil qualities such as chemical composition etc [4]. Therefore, in the present study, we evaluated the effect of different beginning of processing time (12h, 24 h, 36 h and 70 h) after catch on Freshness on meat color and chemical composition of *European anchovy*, E. *encrasicolus* in the Black Sea, Turkey.

II. Materials and Methods

The anchovy caught by purse seine off Sinop in the Black Sea between 15 November and 15 December 2007. After catch of fish, they are transported by camion to the fishmeal factory for processing [5]. We used these fish as raw material in the experiment. The raw material, which is processing in the fish meal factory were composed in 4 different freshness group. These groups were categorized as following criterial:

Group F1: Beginning of processing time after catch of fish anchovy (12 hours)

Group F2: Beginning of processing time after catch of fish anchovy (24 hours)

Group F3: Beginning of processing time after catch of fish anchovy (36 hours)

Group F4: Beginning of processing time after catch of fish anchovy (70 hours)

We determined crude protein, crude lipid, dry matter and ash in those groups separately. In addition, color analysis of the homogenized fish meat was performed. The TVB-N content were measured as Botta et al. [6]. The lipid content was determined by solvent extraction using a method developed by Bling et al. [7]. The protein content was determined by a Kjeldahl method [8]. The moisture content was determined by measuring the mass of a sample before and after drying in an oven [9]. Crude ash content was determined by measuring the mass of a dried sample before and after it

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was heated in a muffle furnace [8]. Values are reported as the average and standard deviation of measurements on fish samples.

Europan anchovy was homogenised by using a homogenizer (IKA-WERKE, DI 25 basic, Germany). The colour was measured from homogenates samples. The homogenate was placed in plastic petri dishes and the colour measurement was repeated 10 times. In the CIELab system L^* denotes lightness on a 0–100 scale from black to white; a^*, (+) red or (−) green; and b^*, (+) yellow or (−) blue [10].

III. Result and Discussion

Samples of anchovy were divided in four freshness groups (F1, F2, F3, F4) as beginning of processing time (12 h, 24 h, 36 h and 70 h) after catch. TVB-N is used in the fishmeal industry to measure the freshness of raw material [11]. The F1, F2, F3, and F4 groups TVBN values (mgN/100 g) were determined as 23.9±0.33, 43.5±0.75, 60.7±1.74 and 96.3± 6.40, respectively (one-way ANOVA, P = 2.729E-14) (Table I). TVB-N value are increased by the effect of the longer storage period [12]-[13][14]. Premium quality fishmeal requires raw material less than 40 mg TVB-N per 100 g [15]. In some countries fisherman are paid for their catch on a scale associated with TVB- N content [16].

TABLE I: TVB-N, crude protein, crude lipid, dry matter and ash values of Freshness Groups

	Freshness groups			
Values	**F1**	**F2**	**F3**	**F4**
TVB-N (mgN/100 g)	23.86 ± 0.328[a]	43.5 ± 0.749[b]	60.74 ± 1.738[c]	96.3 ± 6.399[d]
Crude Protein (%)	16.44 ± 0.039[a]	16.01 ± 0.236[a]	16.24 ± 0.162[a]	16.46 ± 0.063[a]
Crude Lipid (%)	13.43 ± 0.003[a]	11.91 ± 0.379[b]	12.34 ± 0.095[ab]	12.02 ± 0.167[b]
Dry Matter (%)	33.36 ± 0.207[a]	31.27 ± 0.477[b]	32.84 ± 0.26[ab]	32.71 ± 0.459[ab]
Crude Ash (%)	2.54 ± 0.036[a]	2.59 ± 0.120[ab]	2.7 ± 0.057[ab]	2.99 ± 0.049[b]

Different letters within each row (→) represent significant differences (p<0.05) among the freshness groups.

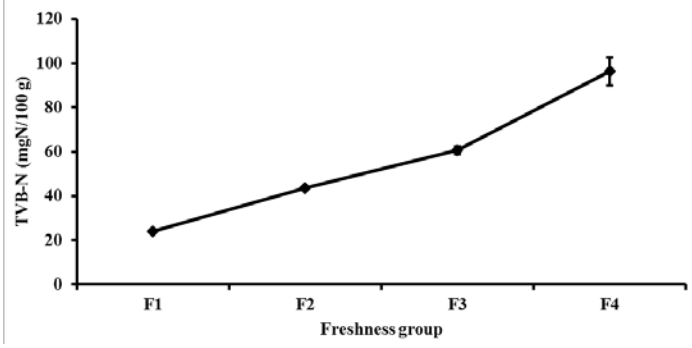

Fig. 1: TVB-N values of freshness Groups

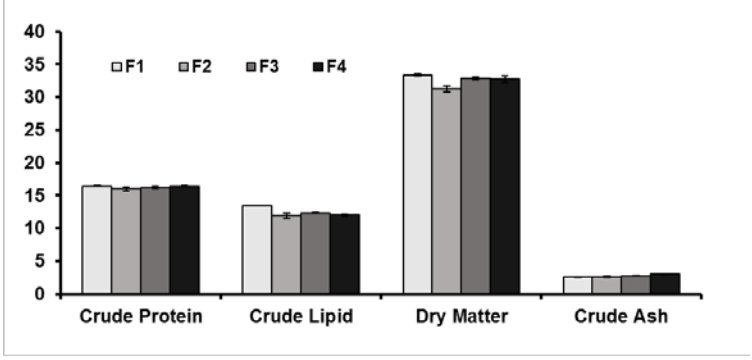

Fig. 2: Crude protein, crude lipid, dry matter and crude ash values of Freshness Groups

Dry matter of the groups were significantly found different between only F1 (33.4±0.21%) and F2 (31.3±0.48%) groups (P = 0.02767), and also crude lipid values significantly different between F1(13.4±0.00%) and F2 (11.9±0.38%) (P = 0.01126), and between F1 and F4 (12.0±0.17%) (P = 0.02048). However, crude ash (P = 0.4984) and crude protein (P = 0.4746) values among the groups were not significantly different (P < 0.05) (Table I). While the results of our study were found similar to some research [17]-[18]- [19], different values have also reported [20]-[21]. Nutritional composition of fish varies accordingly species, region, time, size of fish and so on [22].

TABLE 2: Color L*, a*, b* values of freshness groups

	Freshness groups			
Values	**F1**	**F2**	**F3**	**F4**
Color L	36.16 ± 1.174[a]	37.63 ± 0.787[ab]	40.67 ± 0.372[b]	44.66 ± 0.826[c]
Color a	1.66 ± 0.068[a]	1.45 ± 0.126[a]	1.32 ± 0.084[a]	0.97 ± 0.265[a]
Color b	7.94 ± 0.331[a]	9.06 ± 0.339[ab]	10.44 ± 0.269[bc]	10.71 ± 0.437[c]

Different letters within each row (→) represent significant differences (p<0.05) among the freshness groups.

In this study, Color-a (redness of fish meat) did not effected by freshness of meat (P = 0.07499), but color-b (yellowness of fish meat) (P = 0.000123) and color-l (lightness of meat) (P = 9.601E-09) effected by freshness of whole body. Color a value of all samples gradually decreased during storage (Table 2). However, Color L and b values of sample increased with rising storage time (Fig 3.). This situation was presumably because of the denaturation of myoglobin caused by an acidic pH [23]-[24]. The increase in color b value was related to the formation of a yellowish color on the surface. This was presumed due to the oxidation of pigment under the high oxygen content of air. Lipid oxidation is one of the factor that cause change in color [23]-[25].

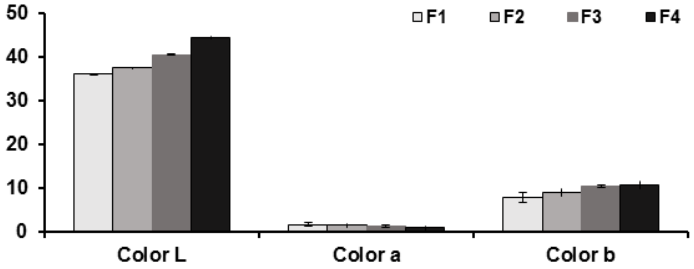

Fig. 3: Color L*, a*, b* values of Freshness groups

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