Interaction between rancidity and organoleptic parameters of anchovy marinade (*Engraulis encrasicolus* L. 1758) include essential oils

Hülya Turan¹ · Demet Kocatepe¹ · İrfan Keskin¹ · Can Okan Altan¹ ·
Bayram Köstekli¹ · Canan Candan¹ · Asuman Ceylan¹

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Abstract This study was carried out to evaluate the lipid oxidation and sensory attributes of anchovy marinated with 10% NaCl+4% alcohol vinegar+0.2% citric acid solution and 0.1% different essential oils. Group A Control: only sunflower seed oil, Group B: sunflower seed oil+0.1% rosemary oil, Group C: sunflower seed oil+0.1% coriander oil, Group D: sunflower seed oil+0.1% laurel oil and Group E: sunflower seed oil+0.1% garlic oil. During storage, lipid oxidation as indicated by the 2-thiobarbituric acid reactive substances (TBARs) values of the control group were significantly higher than the other groups containing essential oils. The results showed that the essential oils have retarding effect on lipids oxidation. This effect was the highest in laurel oil during initial 3 months; and it was similar to laurel oil and rosemary oil in the fourth month; in all the essential oil added groups in 6 month. L*(brightness) values were similar for all groups in first fourth months but, at the last 2 months, group using laurel oil was found better. Yellowness (b*) was similar in all groups during the initial 3 months whereas, after that lower values in the groups that used laurel and rosemary oils were detected. The study concluded that marination with 0.1% laurel oil of anchovy can retard lipid oxidation and improve the sensory attributes of the product during refrigerated storage.

Keywords Anchovy · Marinade · Essential oil · Rancidity

Introduction

The marinate process is definable as a technology that can be treated of fresh or frozen fish and fish parts with acetic acid or other organic acids, salts. This process is without heating effects and defined as maturation. This maturation process increase the shelf life of products. It is one of the oldest methods to be known about food preservation methods, BC7 lasts up to century (Erkan et al. 2000a, b; Varlik et al. 2004). It is reported that marinate process was used for softening, replacement the flavor and texture of meat and so alternative products were made (Poligne and Collignan 2000). Cold marinate is the product which the fish are ripened in acetic acid and salt solution without heat treatment and added different sugar, flavors, brine, sauces and vegetables in it, after this process, fish are packed in glass or plastic box (McLay 1972; Gün et al. 1994). In addition, different marinate types of fish and shell fish were produced, for example; packed in sauce or pickled after heat treatment (Meyer 1965).

In Turkey, marinate which production is increasing and is made different concept is consumed lovely by consumers. One of the best fish used in this technology is anchovy which is heavily caught at certain period in Black Sea. The Black sea anchovy is suitable for marinate with the easy processing and the visual of it after processing. These products are prepared without any heat treatment and have a short storage life of 4–5 months. The cause of the short shelf life are especially rancidity and organoleptic changes.

Black sea anchovy is quite rich in terms of lipid and unsaturated oils (Kocatepe and Turan 2012), for this reason oxidative reactions and rancidity are seen in fish meet. The oxidative process is a reaction involving oxidation oxygen and unsaturated fats. The determination of TBARs (or

✉ Hülya Turan
hturan@sinop.edu.tr

¹ Department of Fish Processing Technology, Fisheries
Faculty, Sinop University, 57000 Sinop, Turkey

TBA) is a common method to determine secondary oxidation products (Rustad 2010).

Sensory analyzes are parameters such as appearance, taste, odor and texture that people sense with their sensory organs. If a product that is acceptable in terms of quality parameters has an unacceptable quality in terms of sensory properties, this product is regarded as non-consumable (Kietzman et al. 1969; Huss 1988; Erkan et al. 2000a, b). The color of food is not stable, in that it changes with decreasing freshness. The appearance of a newly landed fish is unforgettable, in that the interplay of the subtle shades of beautiful colors makes it a joy to behold and irresistible as an item of food. Just a few hours after death, though, it begins to look less obviously attractive, and it's now "ordinary" colors are much more familiar to the majority of the public (Love 1988).

In general essential oils have called different names such as aromatic oils, essential oils or spirit in colloquial, these essential oils are the most important components of plant chemistry (Çelik and Çelik 2007). Essential oils are used in food production due to significant antimicrobial properties. Different essential oils may be effective in different areas with different active substances contained in each (Bayaz 2014). Many researchers have reported that the essential oils have antioxidant and antimicrobial activity (Pandit and Shelef 1994; Baratta et al. 1998a, b, c; Gachkar et al. 2007; Moghtader and Afzali 2009).

This study aims to determine the effects of different essential oils (rosemary, coriander, laurel and garlic) on lipid oxidation and sensory properties of anchovy marinate.

Materials and methods

Fish samples and marinating process

Frozen Black sea anchovy (*Engraulis encrasicolus* Linnaeus, 1758) were used for the marinate production. Frozen anchovy were purchased from a private facility and in cold conditions were brought to the laboratory within half an hour. Head and internal organs of frozen anchovies thawed in cold water were removed. Cleaned fish were immersed into solution including salt (10%), alcohol vinegar (4%) and citric acid (0.2%) in the ratio of 1:2 (fish:marinate solution) for marinating process during 24 h in refrigerator. After marination process, anchovies were removed from the solution and filtered. After then anchovies were placed in plastic box (200 g), and sun flower oil and different essential oils were added below them (Fig. 1). Plastic boxes were sealed to keep air and stored at 4 ± 2 °C for 6 months. This study was conducted in five groups and two replicate. The groups were listed below.

TB: Fresh fish

SS: After marinating process for 24 h

A: Control: Only sunflower oil was added to cover the marinade in box

B: Sunflower oils + 0.1% rosemary oil were added

C: Sunflower oil + 0.1% coriander oil were added

D: Sunflower oil + 0.1% laurel oil were added

E: Sunflower oil + 0.1% garlic oil were added

Methods

To determine the degree of lipid oxidation of raw material, after marinate process and marinate anchovy TBARs analysis was used and the analysis were carried out according to the Erkan et al. (2011). Hunter Lab Chroma meter was used for color. The Commission Internationale de l'Eclairage (CIE)-Lab L*, a*, b* values were recorded, which indicated lightness, redness.

(+)/(−) greenness, and yellowness (+)/(−) blueness, respectively. The sensory analysis form modified from Schormüller (1968) was used for sensory evaluation of marinate anchovy (Table 1). For sensory analysis of groups marinated anchovies were evaluated by eight experienced panelists who have been working as an academicians in fisheries faculty for at least 5 years and have participated in sensory analysis panels many times. After evaluation, groups scoring fewer than 2 points were defined as unacceptable (Table 1).

Significant differences between the groups were determined by MINITAB Release 17 by one-way analysis of variance (ANOVA) using a significance level of $p < 0.05$ by Tukey's test.

Results and discussion

TBARs results

TBARs value of raw material was 4.23 mg/kg; which reached to 5.56 mg/kg after marinating process during 24 h (Fig. 2). Sallam et al. (2007) conducted a similar study on marinated (marinated in 1, 2 and 3% acetic acid solution) Pacific lizard fish (*Cololabis saira*) and found out a significant increase in TBARs values after marinated. The maximum TBARs value was observed for control group (only sun flower oil used) on 30th day. Also during storage period, TBARs values of the control group were significantly higher ($p < 0.05$) than the other groups which include essential oils, showing that the essential oils has the reducing effect on oil rancidity. This effect of essential oils was higher in laurel group (Group D) ($p < 0.05$) during 3 month; in rosemary group (Group B) and laurel (Group D),

Fig. 1 **a** Frozen anchovy, **b** adding of marinate solution, **c** curing process in solution, **d** after marinating process for 24 h, **e** end product

Table 1 Sensory analysis form	1–5 points
<div>Appearance</div> <div>The color of fish, fish settlement status and particle size are appropriate in box</div> <div>The color of fish, fish settlement status and particle size are appropriate in box after the box is turn down</div> <div>Color, texture and brightness of sauce, fish oil and water</div> <div>Odor, Taste and Consistence</div> <div>Odor: the smell of fish, meat and brine are self-pleasing specific</div> <div>Taste: the taste of fish and meat are distinctive and pleasing flavor</div> <div>Effect of essential oil used on fish meat flavor (odor)</div> <div>Effect of essential oil on fish meat taste</div> <div>Consistency: fish meat is suitable texture in view of marinate (slightly hard, not too soft)</div>

Fig. 2 The TBARS changes of marinated anchovies during storage period

in the 4th month; in laurel (Group D), coriander (Group C) and rosemary (Group B) groups in the 5th month; however it was similar in all essential oils during 6th month ($p > 0.05$). Dadalioglu and Evrendilek (2004) determined that bay laurel essential oils contain 1,8-cineole (60.72%), α -terpinene (12.53%), sabinene (12.12%), and α -pinene (6.11%) as major constituents. Another study reported that bay leaves contained mostly 1,8-cineole (50%), eugenol, acetyl eugenol, methyl eugenol, and terpineol (Bayrak et al. 1989). Also Baratta et al. (1998b, c) determined that between the chemical composition of rosemary, coriander and laurel essential oils; laurel essential oil have the more compounds like 1,8-cineole, sabinene, α -terpinyl acetate,

Fig. 3 Group A (control group): Only sunflower oil was added, Group B: Sun flower oils+0.1% rosemary oil were added, Group C: Sunflower oil+0.1% coriander oil were added, Group D: Sunflower

oil+0.1% laurel oil were added, Group E: Sunflower oil+0.1% garlic oil were added (from left to right respectively)

Fig. 4 a L* value changes during storage period, b a* value changes during storage period, c b* value changes during storage period

B-pinene, terpinen-4-ol, methyl eugenol contained. Depending on all the research given above, higher levels of some compounds in laurel oil may have been effective in delaying fat oxidation.

According to Schormüller (1969), the consumption limit in terms of TBARS values MA 8 mg/kg. TBARS value of anchovy used in our study for marinate were determined high because the anchovies were frozen by used air blast freezer at -40°C and stored at -20°C for about 4 months. TBARS values increased after the marinating process more increased within a month due to chemical composition of sun flower added on anchovy marinate. The control groups were not consumable in view of TBARS value, but no noticeable case was detected in terms of taste and smell. Nevertheless, the groups used of essential oil were higher quality than the control groups because of reducing effect on marinating rancidity.

Color measurements

The most effective feature items in appearance to decide on any food are color and brightness. Consumer accept or reject a food on the basis of color (Başoğlu 2001). In

marine product, color measurements is especially used to determining of the color change in the tissue. In our study, brightness (L* value) of fish kept in solution for 24 h increased two-fold because of vinegar effect. Thus, it had come to be desirable to marinate. Similar results regarding with different acid were determined during marinate process of sea foods. For example *Venus verrucosa* in citric acid marinate solution (Kiliç et al. 2008), trout fillets in grape and apple vinegar in marinate solution (Kiliç and Yavuz 2011). During initial 4 months, brightness of all groups were similar ($p > 0.05$). After the third month, the lightness began to reduce in all groups and continue especially in control (A), rosemary (B) and coriander (C) groups until the end of storage period. In the 5th month, the brightness (L*) value of group D (garlic oil) were better, while in the last 2 month group D were better than the other groups ($p < 0.05$) (Fig. 4a). The photos of marinades that can still be consumed in terms of color, flavors and textural aspects at the end of the 6th month are listed below (Fig. 3).

The a* value of fresh fish meat was determined to be 2.46, it reduced to 0.70 (redness) after marinating process (Fig. 4b). In the first 2 month of storing, +a* values of control group were measured as negative direction

Fig. 5 **a** The color of fish, fish settlement status and particle size are appropriate in *box*, **b** the color of fish, fish settlement status and particle size are appropriate in *box* after the *box* is turn down, **c** sauce, color, texture and brightness of fish oil and water, **d** odor: the smell of fish, meat and brine are self-pleasing specific, **e** taste: the taste of fish

and meat are distinctive and pleasing flavor, **f** the palpability on fish meat flavor of essential oil used (odor), **g** effect of essential oil on fish meat taste, **h** consistency: fish meat is suitable texture in view of marinate (slightly hard, not too soft)

($-a^*$ greenness) until the end of the storage period. In the other groups which was used essential oils, $-a^*$ values were determined until to last month from first month, except for $+a^*$ values determined in last 2 months in group B (rosemary oil). The summaries, the effect of essential oils was not important on a^* values of marinade.

The b^* values of fresh fish meat was detected as 2.91 and this value reached to 5.13 (Fig. 4c) after the marinate process continued for 24 h. Yellowness ($+b^*$) color of all groups were similar in the first 3 month ($p > 0.05$). In the last 3 months, the lower values were found in group B and D ($p < 0.05$) added rosemary and laurel oil, respectively.

The b^* values increased as a result of lipid oxidation in the product.

It can be inferred that, b^* values increased because of yellowing as a result of lipid oxidation in the product. Changes in the value of b^* of D group used laurel was found within more narrow limits than other all the groups added essential oils.

Sensory analysis

Sensory evaluation is a very important analysis for determining shelf life of marinated products (Kiliç and Çaklı 2004). The points regarding with convenience of the color of fish, fish settlement status and particle size, sauce, color, brightness of fish, oil and water in box and in box after the box is turn down were similar for all groups but, less point was given in 5th and 6th months. This was caused by losses in quality of fish and the negative effects of yellowing of fish and meat due to the rancidity over time. Similar findings were reported by other researchers as well (Duman et al. 2015). Especially in the 6th month, group C added coriander oil has the worst point (Fig. 5a–c). Similar results were reported by Guran et al. (2015) the influence of different essential oils (thyme, clove, rosemary) on bonito fish patties.

In terms of unique pleasing odor of fish meat and pickle, there no differences until the 5th month between the group's including essential oils, but in the last month, group C was found the least popular group. The maximum perceivable group in view of both odor and taste of essential oil was in group D (laurel oil), but minimum in group C (coriander oil) (Fig. 5d, f). The taste scores decreased during the storage period and group C were the least popular group at 6th month. The greatest effect of essential oil on the fish meat taste had been felt in the group which added laurel oil. Coriander oil had been the least effective oil on the fish meat flavor (Fig. 5e, g). Also group C added coriander oil, which was the least preferred product by all panelists.

Conclusion

The results showed that addition of different essential oils to marinate solution provided better quality products. Laurel essential oils were more perceivable and desirable than the other essential oils in terms of odor and taste. In contrast, the marinated anchovy containing coriander essential oil were not liked by panelist. It can be said that laurel essential oil can be used at the level of 0.1% in marinade production for both retarding the lipid oxidation and favourable effect in terms of odor and taste.

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