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Original Paper

Quality changes of fish patties produced from anchovy during refrigerated storage

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Abstract Quality changes of anchovy patties at the storage temperature of 4 °C were investigated. After patties had been prepared using minced anchovy meat they were stored in a refrigerator. Quality control analyses were conducted for every day of storage. Total volatile basic nitrogen and thiobarbutiric acid values increased, and acidity and sensory scores decreased during the storage. The peroxide value significantly increased until the fifth day of storage then decreased on days 5 and 6 of storage. Anchovy patties were consumable up to 6 days.

Keywords Anchovy · Patty · Peroxide · Thiobarbutiric acid · *Engraulis encrasicholus*

Introduction

Anchovy (*Engraulis encrasicholus*) is a fish species, and constitutes the most important quantity of total fish production in Turkey. More than of 60% of total fish production is anchovy [1]. A significant portion (around 60%) of total anchovy production is utilized for human consumption

and the remainder is processed into by-products such as fish meal and fish oil particularly at times when the catches are large [2, 3]. As a traditional product for many years, anchovies have retained their popularity as the most common fish caught in Turkey. Its suitability for further processing (salting, marinating, canning and processing to fish oil, etc.) has lead to industrialization. Also there are many meals in which anchovies are very popular in the cuisine of the Black Sea region. Among these, fried anchovies, anchovy soup, anchovy pickles, anchovies in rice, anchovies in olive oil and anchovy composts are the most popular ones [4].

The demand for ready-to-eat and/or ready-to-cook meals is gradually growing owing to their convenience. Among food items, fish products are very popular. Fish patties are ready-to-eat foods and are produced from various fish species. Anchovy is a very suitable species for fish patty production owing to its fat content. It is not common to consume fish patties in Turkey. The fish generally are consumed fresh.

One aim of this study was to produce anchovy patties and to investigate the quality changes during refrigerated storage. Another aim was to evaluate the excess of anchovy production as an alternative to the other consumption forms.

Materials and methods

Raw material

Fresh anchovies (*E. encrasicholus*) were provided from the fish market of Antalya in December 2003. The fish purchased were transferred in ice at 0 °C to the market within 24 h after harvesting. After purchase, the fish were transferred to the laboratory in polystyrene boxes with crushed ice within 1 h. In total 10 kg of fish with an average weight of 12.65±1.75 g was taken. On arrival at the laboratory, quality control analyses of the fish were performed and patties were prepared.

Patties preparation

The fish were beheaded, gutted, filleted and washed. After the handling process, the fish were boiled in boiling water for 2–3 min and then minced using a kitchen blender. Ingredients were added to the minced fish according to the following formulation: 0.7% salt, 6% mashed potatoes, 0.9% bread, 4% onion, 0.5% cumin, 0.4% black pepper, 0.5% thyme, 5% red pepper, 1% egg. Minced fish and ingredients were mixed thoroughly in the blender, shaped by hand and coated

with wheat flour. Patties were placed into plastic boxes, wrapped with stretch film and stored in a refrigerator (4 °C).

Analyses

Quality control analyses of patties were conducted during storage at daily intervals until they became unacceptable for human consumption.

Chemical analyses

Total volatile basic nitrogen analysis

A 10 g sample was washed into the distillation flask and 1 g magnesium oxide and a drop or two of antifoam solution were added. The samples were boiled and distilled into 10 ml 0.1 N HCl solution with added indicator in a 500-ml conical flask. After the distillation, the contents of the conical flask were titrated with 0.1 N NaOH and the total volatile basic nitrogen (TVB-N) was calculated [5].

Peroxide value

The peroxide value (PV) was determined using the method described by the American Oil Chemists' Society [6]. The sample was dissolved in 30 ml glacial acetic acid–chloroform solution (3/2 v/v) and 1 ml KI solution (14 g KI/10 ml distilled water) was added. Distilled water (30 ml) was added after 1 min and the mixture was titrated with 0.01 N sodium thiosulfate until the yellow color was lost. Then 5 ml starch indicator was added and the solution was titrated again with 0.01 N sodium thiosulfate until the blue color disappeared. The PV was calculated using the following formula:

$$\mathrm{PV(mEq/kg)} = (V - B \times N_{\mathrm{f}}/W) \times 1000,$$

where V is the volume of sodium thiosulfate consumed, B is the volume of normal sodium thiosulfate consumed during a blank titration, W is the weight of the sample (grams) and N_{f} is the normality of sodium thiosulfate multiplied by a factor.

Thiobarbutiric acid analysis

The thiobarbutiric acid (TBA) distillation method was performed as described by Tarladgis et al. [7]. A homogenized 10 g sample was distilled after addition of 2.5 ml HCl and distilled water solution (1+2). A 5 ml aliquot of distilled solution was transferred into the stoppered test tube and 5 ml TBA solution (0.288 g TBA/100 ml distilled water) was added. The test tube was shaken and

was left in a water bath at 110 °C for 35 min. The absorbance was determined by a spectrophotometer at 538 nm against a blank containing distilled water and TBA solution. The results were expressed as milligrams of malonaldehyde per kilogram of fish flesh.

Acidity

Acidity was determined as acetic acid according to the methods given by Lees [8]. The method was based on titration using NaOH and phenolphthalein as an indicator.

Sensory analysis

The fish were assessed on the basis of appearance, odor and texture characteristics using a nine-point hedonic scale [9]. A score of 7–9 indicated "very good" quality, a score of 4.0–6.9 indicated "good" quality and a score of 1.0–3.9 denoted spoiled. Five panelists, staff members of the department of food engineering who are familiar with fish and fish products, and who usually include fish products in their diet, were chosen for the sensory analysis. Patties were fried in deep fat using sunflower oil before being presented to the panelists.

Statistical analysis

Data were subjected to analysis of variance followed by Duncan's multiple range test as appropriate statistical analytical systems.

Results and discussion

Volatile bases result from degradation of proteins and nonprotein nitrogenous compounds, mainly as a result of microbial activity [10]. TVB-N is widely used as an indicator for fish deterioration [11].

The initial TVB-N value in the anchovy patties was 17.37 mg/100 g in this study (Fig. 1). This value increased progressively throughout storage but this increase was not significant ($p>0.05$) until day 6 of storage. The legal limits set for these indexes at 35 mg/100 g for TVB-N [12] were not exceeded throughout storage.

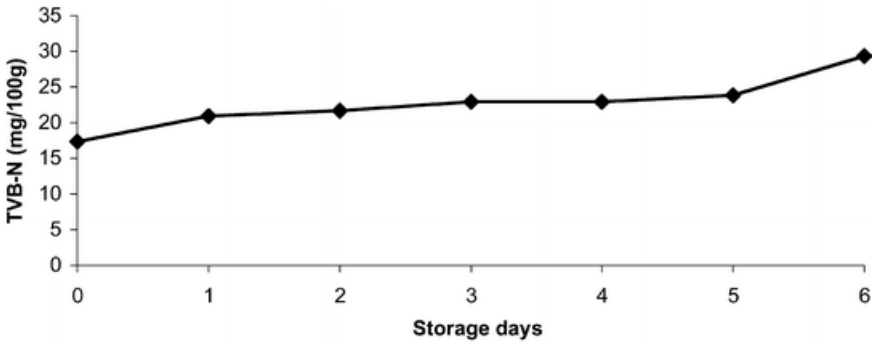

Fig. 1 Changes in total volatile basic nitrogen (*TVB-N*) values of anchovy patties during refrigerated storage.

Yanar and Fenercioglu [13] reported that the initial TVB-N value of fish ball produced from carp was 10.52 mg /100 g and this value increased during frozen storage of 6 months.

Unlusayin et al. [14] found initial TVB-N values of 11.4 mg/100 g and 11.2 mg/100 g in fish balls produced from pike perch and tench, respectively. They also stated that the TVB-N values increased to values of 39.6 mg/100 g and 36.2 mg/100 g in 14 days at 4 C. The initial TVB-N value of African catfish mince balls was found to be 14 mg/100 g by Ersoy and Yılmaz [15].

The presence of TBA reactive substances is due to the second stage auto-oxidation during which peroxides are oxidized to aldehydes and ketones. High values are undesirable because they are associated with rancid odors [15]. The hydroperoxides can react further to give a wide range of compounds, some of which are responsible for the rancid odors and flavors in oily fish and for cold storage odors and flavors in fish. Malonaldehyde and a number of related compounds can be separated from the fish either by distillation or by preparing a protein-free extract. Reaction of these compounds with 2-thiobarbituric acid gives rise to colored products, the amount of which, the TBA value, is measured using a spectrophotometer. The increase in the TBA value is a measure of the extent of oxidative deterioration in oily fish, but, as in the case of the PV, the TBA value can fall again at a later stage of spoilage [17].

The TBA results are presented in Fig. 2. The initial TBA value was 10.61 mg malonaldehyde per kilogram of the sample and it increased significantly ($p<0.01$) to 19.27 mg/kg on day 3 of storage. The TBA concentrations stayed more or less constant on days 3 and 4 of storage and then increased significantly ($p<0.01$) until the end of storage, when they reached values of 27.21 mg/kg.

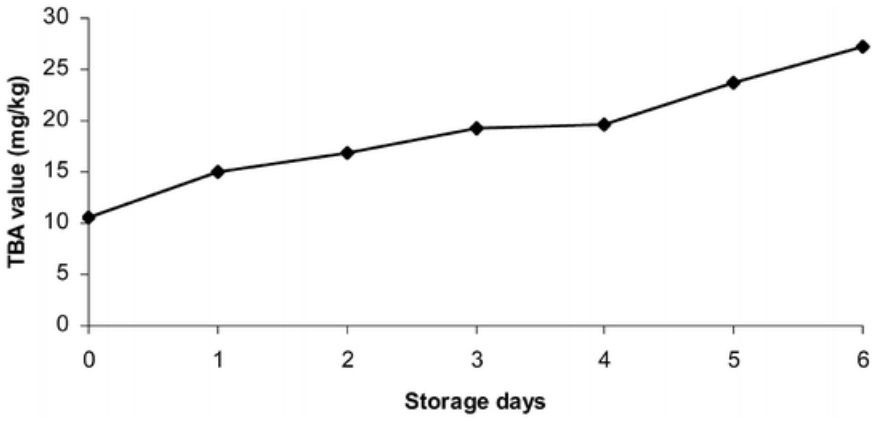

Fig. 2 Changes in thiobarbutiric acid (*TBA*) values of anchovy patties during refrigerated storage.

Simeonidou et al. [18] found TBA values of 85 mg/kg after 6 days of storage of hake in ice. Ruiz Capillas and Moral [19] found TBA values of 7.6 mg/kg in hake stored in ice at the end of storage of 25 days. They also stated that it would be difficult to set limits for TBA levels without first doing studies on the factors possibly affecting this index, such as species, fat content, season of the year and evisceration.

Yanar and Fenercioglu [13] found an initial TBA value of 0.6 mg/kg in carp balls. Dzudie et al. [20] found that TBA values of beef patties increased during the storage at 4 °C and they stated that this increase indicated that oxidative deterioration of lipid into the end products (malonaldehyde) occurred during storage.

The most common cause of oil deterioration is rancidity and the most common cause of rancidity in oils and fats is oxidation. Oxidation of the oil, in oily fish, gives rise to rancid odors and flavors; these can limit the storage life of such species more quickly than the protein changes that govern the extractable protein value. An important stage in the oxidation is the reaction of oxygen with the unsaturated fatty acid molecules to form hydroperoxides; the amount of these can be used as a measure of the extent of oxidation in the early stages. The peroxide test is a measure of the formation of hydroperoxides. An increase in the PV is most useful as an index of the earlier stages of oxidation; as oxidation proceeds and peroxides are degraded the PV can start to fall.

PV results are shown in Fig. 3. The initial PV of fish patties was 1.40 mEq/kg. The PV increased significantly ($p<0.01$) until the fifth day of storage then decreased on day 5 and 6 of storage. The decrease of the PV at the end of storage may occur owing to decomposition of hydroperoxides into secondary oxidation products.

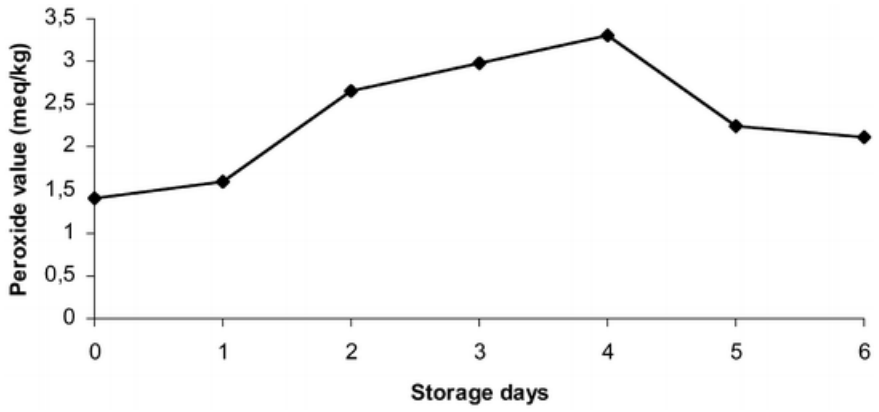

Fig. 3 Changes in peroxide values of anchovy patties during refrigerated storage.

The acidity of the patties decreased during the storage but this decrease was not significant statistically (Fig. 4). The pH of fish muscle remains high (above 6) after death, favoring microbial growth and enzymatic activity [21, 22]. In the studies of other researchers [13, 14, 15, 23, 24] the acidity of fish patties decreased and pH values increased during storage.

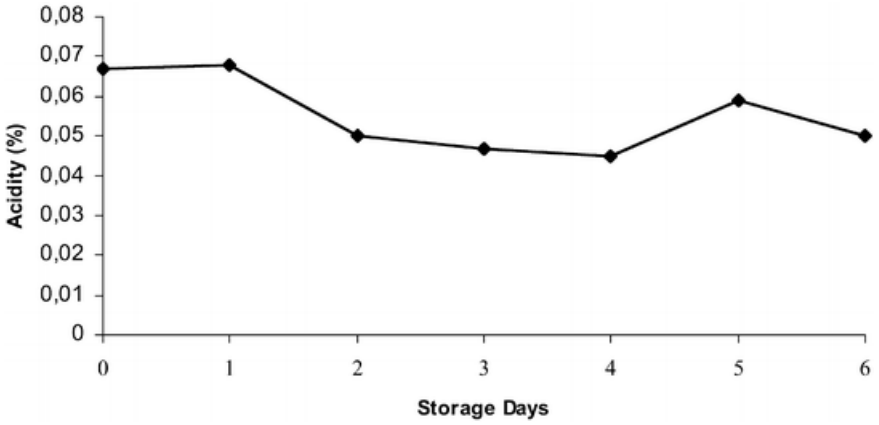

Fig. 4 Changes in acidity of anchovy patties during refrigerated storage.

Sensory scores of fish patties decreased significantly ($p<0.05$) throughout storage (Fig. 5). The samples had “very good” quality up to 2 days and “good” quality up to 6 days. The samples were unfit for human consumption at 6 days. These findings are in agreement with the results described by Turhan et al. [24]. In the other research the shelf life of fish patties at 4 °C was found to be 10 days [14, 23, 25]. The probable reason of these differences is thought to be differences in the quality of the raw material.

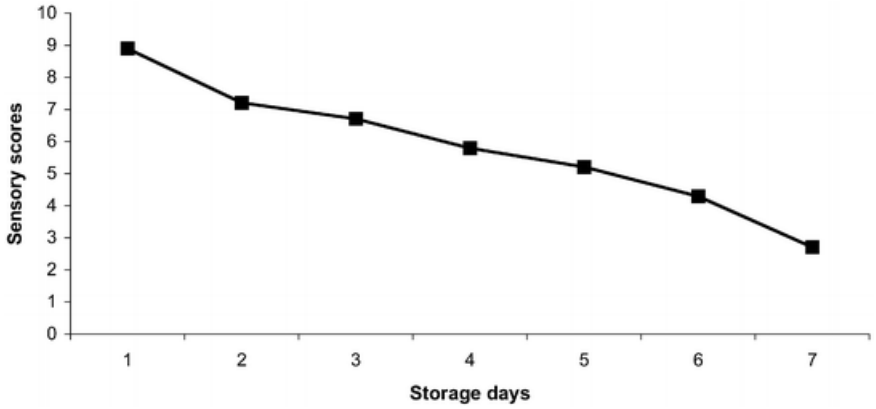

Fig. 5 Changes in sensory evaluation of anchovy patties during refrigerated storage.

Conclusion

Anchovy is a good source for producing fish patties. Fish patties can be an alternative food and a way of evaluating the overfishing of anchovy. The quality of these kinds of products depends on the quality of the raw material and the storage conditions. If high-quality material is chosen, then the shelf life of the product will be longer and the product will be safer. The variety of fish patties can be increased using different formulations and materials. Thus, the fish can be consumed in different ways and fish consumption can be increased.

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