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Preparing fishballs and ground meat from Aras dam *Abramis barama* and evaluating their quality and shelf life in freezing

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ABSTRACT

Abramis brama of Aras Dam is not consumed fresh for reasons such as small size, unpleasant smell, and many bones. *Abramis brama* accounts for more than 1000 tons of the annual catch in Aras Dam. Due to the high volume of catch in a short time and inappropriate storage and transportation, about 90% of these fish are used for fish meal processing. Therefore, the present study was conducted to produce ground meat and fishballs from these fish, evaluating their chemical, microbial, and sensory quality and shelf life at freezing temperatures. The treatments included ground meat and fishballs (2 treatments). 0.2% BHT antioxidant was used to ground meat production. The treatments were kept at -18 ºC for six months. *Salmonella*, *Pseudomonas*, coliform, *Escherichia coli*, mold, and yeast were not observed in the samples. In minced fish and fishballs TVB-N (13.53-14.25 mg/100g), pH (6.89-6.92), peroxide (1.29-1.39 meq/kg lipid), TBARS (1.67-1.89 mg MDA/kg) and the total bacterial counts (1.53-1.75 logCFU/g) were acceptable at the end of storage time. Staphylococcus was not observed in these treatments after two months of storage. Sensory properties including texture (3.24 - 3.72), odor (3.52 – 4.10), color (3.15 - 3.68), taste (3.42-3.80), and overall acceptance (3.39-3.90) were of good quality in fishball and minced fish treatments. Moisture, protein, fat, and ash were 69.12 - 73.26%, 17.24- 19.12%, 4.71 - 4.85%, and 1.01 - 1.52%, respectively in fishball and minced fish treatments. Because the nutritional value of the examined treatments was high, and chemical, microbial, and sensory characteristics were determined acceptable at the end of the storage time, the food industry is advised to prepare fishballs and ground meat from Abramis brama.

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1-Introduction

Fish and fish products are known as a good source of protein and micronutrients such as fatty acids, minerals, amino acids and vitamins. Fish processing in Iran is not diverse and the most common form of processing industry in the country is the production of canned goods, burgers, fingers, sausages and fillets in vacuum and normal packaging. But according to aquatic resources, low price and high nutritional value, the production of products with added value from them, such as fish balls, has a suitable position [1]. Fishballs are dough products that are prepared from minced meat, dough or fish surimi along with flour and spices, which are cooked in different ways after production such as boiling or frying. Several studies were conducted on the production and quality stability of fishy fast food dough products such as cakes, crackers, meatballs, and burgers from marine fish species, but little information is available about warm blue freshwater species. Freshwater fish are highly desirable sources of high-quality protein because they are balanced in terms of essential amino acids and highly digestible [2]. There is a lot of potential in freshwater fish, which can be successfully used in the industry of dough products and products based on it, including meatballs, burgers, fish fingers, steaks and other products. Traditionally, freshwater and marine fish species are used to make fish balls. Fish meatball is a very popular and delicious food in the fast food industry. Fish balls are popular products based on minced fish meat in the Southeast Asian region, especially in Thailand, Singapore, East and Southeast Asia, Europe (especially Northern Europe), and some West African coastal countries. Good quality fish balls are white in color, odorless and soft but elastic in texture. In Asia, they are consumed as a snack or added to soups and hot dishes. They are usually attributed to Chinese cuisine [3].

In recent years, as there has been an increase in urbanization and the population of working women, consumer preference has shifted significantly towards ready-to-eat foods, including fish balls. Working people along with the new generation of students and youth are now more dependent on convenience foods. As a result, in recent years, many centers for the supply of ready-to-eat foods have been opened in different regions, and due to the simplicity and convenience of fish meatball production technology and the fact that it does not require complex machinery, this product can be offered in fast food and ready-to-eat food supply centers. [4].

Khalmkhali (Scomber scombrus), tilapia (Tilapia of the sea)، (Lutjanus griseus) snapper،(Epinephelus) grouper and lionfish (Scomberomorus commerson) are fish, which are used to prepare meatballs [5]. wire fish from the carp family Cyprinidae And sex Abramis is this Fish lives in the Anzali lagoon and the rivers leading to it, the Sefidroud river, the mouth of the Volga river, Ural, Kura and Aras dam lake. [6]. Wire fish weighing more than 1 kg has an economic value and is welcomed by consumers. Sim Aras fish is not welcomed in the market due to the smell of its meat, which is caused by the environment and nutrition, as well as having many bones, and a very low price is assigned to it. but Due to its good growth, it is considered one of the fish with low economic value. Due to its soft meat and wide use in aquaculture, this fish is the raw material for preparing dough products such as meatballs. Until now, the production of products such as burgers, fingers, surimi and protein powder from wire fish has been investigated [7 and 8]. Currently, salted and smoked products are the products of this fish. In addition, the small sizes of this fish are used to produce fish powder. Therefore, the present study was carried out with the objectives of preparing minced meat and meatballs from Aras dam wire fish, evaluating and comparing the microbial, chemical and sensory quality and determining their shelf life.

2 – Method and Material

The wire fish was caught in a weight of 500-800 grams and covered fresh using ice to the ratio of 2 times the weight of the fish and transferred to the production line of the aquatic processing plant. then washed and after removing the head and tail and filleting and washing again using the machine Deboner Meat was removed. Then the fish meat is entered into the mixing machine and additives include polyphosphate 0.3%, sorbitol 1%, butylene hydroxytoluene antioxidant (BHT) 0.2% and salt 0.3% was added. The meat was packed in 250 grams using polyethylene plastics [9 and 10].

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The processing steps for preparing fish meatballs include washing, fleshing, rinsing, dewatering, molding, packing and freezing. 50 kg of minced meat was used to prepare fish meatballs. Then fillers such as potato starch 10%, salt 2 – 1.5%, liquid oil 1%, mixed spices (in equal proportions of cinnamon, pepper, cloves, mustard) 2 – 1%, garlic powder 1%, onion powder 5%, ice 10%, monosodium glutamate 1% and sorbitol 1% were added to it. The meat and other ingredients were mixed in the mixer for 10 minutes, so that the temperature of the prepared mixture was maintained at less than 10 degrees Celsius. Meatballs weighing 25 – 20 grams were prepared. Meatballs using hot water at 90 degrees Celsius for 10 – They were cooked for 8 minutes and after cooling, they were packed using polyethylene plastics. Meatballs packed at 35 – degrees Celsius were frozen [2 and 10].

Treatments of fish meatballs and minced fish meat at 18 temperature – degrees Celsius were kept. Their quality was evaluated using microbial, chemical and sensory tests and their shelf life was determined. Sampling for fish meatballs and minced fish meat was done after processing and then once every month for 6 months.

Among the chemical factors, peroxide was determined by iodometric titration method, thiobarbituric acid by colorimetric method and total volatile organic compounds by titration method [11]. From the physical tests, the pH was checked using a pH meter. Sensory characteristics including smell, color, texture, taste and overall acceptance were evaluated by 5-point hedonic method [12]. Sensory evaluation by 30 male and female trained evaluators with an average age of 40 – It took 30 years. To determine the degree of acceptability and evaluate each of the sensory characteristics of 5 points – 1 was considered. Scores of 5.4, 3.2 and 1 indicate very good, good, average, bad and very bad, respectively. Microbial factors such as total number of bacteria [13, 14], Salmonella [15], Staphylococcus [16], coli¬Form [17], Escherichia coli [17], Pseudomonas [18] and mold and yeast [19] were investigated by culture method. Also, the nutritional value of minced meat and meatballs were determined using moisture by dry oven method, protein by acid digestion method, fat by distillation method (Soxhlet) and ash by gravimetric determination method [20]. Sampling was done randomly.

The results obtained from the tests of minced meat and fish meatball treatments during storage were compared using SPSS version 25 software to investigate the effect of storage time on the changes in the microbial, chemical and sensory characteristics of the experimental treatments. Two-way analysis of variance was used to check the changes of the experimental treatments during the storage time of the statistical test.

3- Results

Table 1 – Evaluation of the nutritional value of minced meat and fish meatballs of Sim Sed Aras during storage for six months in cold storage (percentage)

Index	Ash		Protein		Fat		Moisture	
Treatment Sampling time (Month)	Minced fish	Fish ball	Minced fish	Fish ball	Minced fish	Fish ball	Minced fish	Fish ball
Zero time	1.27±0.23 [a]	1.98±1.33 [a]	19.54±1.42 [a]	18.57±1.14 [a]	5.32±1.15 [a]	5.18±1.26 [a]	74.84±1.17 [a]	73.30±1.34 [a]
First	1.27±0.33 [a]	1.98±1.14 [a]	19.49±1.25 [a]	18.19±1.11 [ab]	5.32±1.21 [a]	5.18±1.17 [a]	74.64±1.16 [a]	73.15±1.96 [a]
Secound	1.14±0.19 [a]	1.93±1.17 [a]	19.37±1.23 [a]	17.97±1.12 [bc]	5.21±1.12 [a]	5.13±1.11 [a]	74.53±1.18 [ab]	72.23±1.85 [b]
Third	1.11±0.24 [a]	1.80±1.16 [a]	19.31±1.24 [a]	17.61±1.14 [c]	5.19±1.15 [a]	4.96±1.16 [a]	74.13±1.19 [bc]	71.81±1.41 [b]
Fourth	1.05±0.25 [a]	1.72±1.27 [a]	19.26±1.27 [a]	17.53±1.34 [cd]	5.12±1.23 [a]	4.90±1.37 [a]	73.89±1.21 [cd]	71.16±1.39 [c]

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Fifth	1.05±0.32 a	1.58±1.23 a	19.23±1.63 a	17.42±1.38 d	4.94±1.38 a	4.82±1.51 a	73.50±1.35 of	70.35±1.76 d
Sixth	1.01±0.42 a	1.52±1.26 a	19.12±1.73 a	17.24±1.56 d	4.85±1.56 a	4.71±1.73 a	73.36±1.39 and	69.12±1.34 and

Dissimilar letters in a row indicate a significant difference at the 5% level ($p<0.05$).

As can be seen in Table 1, unlike moisture, fat, protein and ash did not show significant changes when the experimental treatments were kept in the cold storage ($p>0.05$).

Table 2 - Evaluation of the chemical properties of minced meat and fish meatballs from Sim Sad Aras during storage for six months in cold storage

Index	(meq/kg lipid) PV value		pH		TBARS (mg MDA/kg)		TVB-N (mg/100g)	
Treatment Sampling time (Month)	Fish ball	Minced fish	Fish ball	Minced fish	Fish ball	Minced fish	Fish ball	Minced fish
Zero time	0.53±0.12 c	0.35±0.18 c	6.12±1.17 c	6.14±1.57 b	0.19±0.05 and	0.21±0.12 f	9.83±1.56 and	9.87±1.12 f
First	0.87±0.36 bc	0.68±0.44 c	6.19±1.22 bc	6.22±1.21 b	0.42±0.23d and	0.62±0.14 ed	10.70±1.89 d	10.90±1.95 and
Second	1.75±0.54 a	1.97±0.73 a	6.27±1.11 b	6.26±1.13 b	0.67±0.32 d	0.84±0.24d and	11.26±1.39 c	1.99 and ±11.21
Third	1.65±0.35 a	1.85±0.38 a	6.41±1.14 b	6.39±1.43 b	0.83±0.35 cd	0.97±0.32 cd	11.98±1.48 b	1.03 d ±11.75
Fourth	1.59±0.49 a	1.74±0.41 a	6.56±1.28 ab	6.54±1.23 a b	1.14±0.21 bc	1.36±0.25 bc	12.36±1.37 ab	12.56±1.23 c
Fifth	1.47±0.56 a	1.53±0.52 ab	6.75±1.33 a	6.73±1.21 a	1.34±0.59 ab	1.54±0.38 ab	12.78±1.56 a	13.47±1.38 b
Sixth	1.29±0.59 ab	1.39±0.76 b	6.92±1.39 a	6.89±1.17 a	1.67±0.49 a	1.89±0.52 a	13.53±1.68 a	14.25±1.43 a

Dissimilar letters in a row indicate a significant difference at the 5% level ($p<0.05$).

According to Table 2, pH, peroxide, thiobarbituric acid and total volatile nitrogenous bases were significantly different in the experimental treatments until the end of the cold storage time. ($p<0.05$). These indicators were within the permissible range in experimental treatments.

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Table 3 – Evaluation of the sensory characteristics of minced meat and fish meatballs of Sim Sad Aras during storage for six months in cold storage

Treatment	Fish ball					Minced fish				
Index Sampling time (Month)	Overall acceptance	Taste	Texture	Color	Odor	Overall acceptance	Taste	Texture	Color	Odor
Zero time	4.26±1.62[a]	4.19±1.60[a]	4.15±1.43[a]	4.03±1.27[a]	4.34±1.34[a]	3.71±1.39[a]	3.76±1.36[a]	3.52±1.41[a]	3.52±1.13[a]	3.93±1.38[a]
First	4.21±1.28[a]	4.11±1.21[a]	4.12±1.49[a]	3.99±1.67[a]	4.30±1.57[a]	3.70±1.25[a]	3.75±1.28[a]	3.52±1.47[a]	3.41±1.42[a]	3.89±1.42[a]
Second	4.14±1.39[a]	4.04±1.32[a]	4.07±1.75[a]	3.96±1.59[a]	4.24±1.59[a]	3.62±1.27[a]	3.66±1.22[a]	3.46±1.68[a]	3.37±1.28[a]	3.78±1.56[a]
Third	4.12±1.97[a]	3.92±1.94[a]	3.95±1.73[a]	3.85±1.82[a]	4.23±1.65[a]	3.53±1.56[a]	3.57±1.53[a]	3.37±1.79[a]	3.31±1.34[a]	3.72±1.68[a]
Fourth	3.95±1.80[a]	3.90±1.88[a]	3.86±1.49[a]	3.83±1.97[a]	4.15±1.73[a]	3.47±1.52[a]	3.52±1.58[a]	3.32±1.49[a]	3.29±1.18[a]	3.67±1.64[a]
Fifth	3.94±1.71[a]	3.84±1.75[a]	3.84±1.28[a]	3.74±1.89[a]	4.12±1.68[a]	3.40±1.62[a]	3.45±1.69[a]	3.30±1.27[a]	3.21±1.24[a]	3.60±1.48[a]
Sixth	3.90±1.78[a]	3.80±1.70[a]	3.72±1.44[a]	3.68±1.93[a]	4.10±1.57[a]	3.39±1.76[a]	3.42±1.72[a]	3.24±1.29[a]	3.15±1.35[a]	3.52±1.57[a]

Dissimilar letters in a row indicate a significant difference at the 5% level ($p<0.05$).

Sensory characteristics, including smell, color, texture, taste and overall acceptance, were not significantly different in meatballs and minced meat treatments during cold storage ($p>0.05$) (Table 3).

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Table 4 – Evaluation of microbial characteristics of treatments of minced meat and fish balls of Sim Sad Aras during storage for six months in cold storage (log CFU/g)

Treatment	Fish ball					Minced fish				
Bacteria Sampling time (Month)	Staphylococcus bacteria	Salmonella	Coliform and Escherichia coli	Yeast and mold	Total bacterial counts	Salmonella	Coliform and Escherichia coli	Yeast and mold	Staphylococcus bacteria	Total bacterial counts
Zero time	1.90±0.98[a]	<10	<10	<10	2.72±0.36[a]	<10	<10	<10	2.11±0.63[a]	3.11±0.83[a]
First	1.49±0.87[ab]	<10	<10	<10	2.59±0.43[ab]	<10	<10	<10	1.59±0.76[b]	2.89±0.18[a]
Second	1.05±0.75[b]	<10	<10	<10	2.31±0.53[bc]	<10	<10	<10	1.26±0.59[b]	2.71±0.19[a]
Third	<10	<10	<10	<10	2.18±0.35[cd]	<10	<10	<10	<10	2.58±0.57[b]
Fourth	<10	<10	<10	<10	1.95±0.24[of]	<10	<10	<10	<10	2.37±0.43[c]
Fifth	<10	<10	<10	<10	1.72±0.48[and]	<10	<10	<10	<10	2.18±0.29[cd]
Sixth	<10	<10	<10	<10	1.53±0.52[and]	<10	<10	<10	<10	1.75±0.43[d]

Dissimilar letters in a row indicate a significant difference at the 5% level ($p<0.05$).

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As can be seen in Table 4, infection with cold-loving bacteria, salmonella, coliform, Escherichia coli, mold and yeast was not observed in the experimental treatments. Staphylococcus bacteria and the total number of bacteria in the experimental treatments were within the permissible range declared according to the national standard of Iran. Staphylococcus bacteria were present in the test samples of meatballs and minced meat until the second month, and during this period, they showed a significant difference. (05/0>p). These bacteria were not observed from the second month to the end of the cold storage period. The total number of bacteria during the storage time in the cold room showed a significant difference in the experimental treatments (05/0>p).

4 - Discussion

Seafood products, including fish meatballs, are widely consumed due to their high protein and low cholesterol content [21]. Protein, fat, moisture and ash in meatballs (1.25, 69.12, 4.71 and 17.24%) and minced meat (1.01, 72.36, 4.85 and 19.19%) of fish showed high values (Table 1). Moisture content is the percentage of water in the product. Moisture content can affect product quality and shelf life. The use of ice in the composition of meatballs may increase its water content. Researchers believe that the main activity of polyphosphates used to process minced meat is to improve the efficiency of fish protein to bind with water. The mechanism of this action has not been proven, but mainly they affect the surface of the fish [22]. Ash is a mineral that remains from the combustion of organic matter at high temperature. In minced meat, polyphosphates play an important role in increasing the nutritional value of the product, because their ability to chelate and stabilize minerals is well known. [22]. Also, the additives used in the processing of minced meat and meatballs are another factor to improve the ash in these products._Yusuf et al. (2023) moisture, ash and protein values in frozen catfish meatballs (Pangasianodon hypophthalmus) During 30 days of storage, they determined 72.26, 1.22 and 8.86 percent, respectively. [3]. The lilac et al. (2024) evaluated the protein in panga fish balls prepared with 1% moringa leaf powder during 15 days of storage at 4 degrees Celsius. Fish meatballs contain a lot of protein (20/30 – was 20.81 percent). [5]. Kunyaboon and colleagues (2021) Lipid oxidation changes of washed mincemeat of silver carp fish.Hypophthalmichthys molitrix) were examined. These researchers stated that the total fat in unwashed meat changed from 11.45 to 9 percent [23]. In the present study, the amounts of protein, fat, moisture and ash in meatballs were determined as 17.24, 4.71, 69.12 and 1.25% and in minced meat as 19.12, 4.85, 72.36 and 1.01%, which were different compared to recent studies. The difference in these studies compared to the present study can be found in the type of fish, the use of antioxidants, Muscle type, oxidative reaction status, protein solubility, freezing temperature, freezing techniques and incomplete thawing processes. related.

Peroxide and thiobarbituric acid in meatballs and minced meat were of good quality until the end of storage time in cold storage. Considering that peroxide and thiobarbituric acid respectively in the range of 10 – 5 mg/kg of fat and 2 mg of malondialdehyde/kg are acceptable, these indicators were acceptable in the treatments of meatballs (1.29 mg/kg of fat and 1.67 mg of malondialdehyde/kg) and minced meat (1.39 mg/kg of fat and 1.89 mg of malondialdehyde/kg) (Table 2). Due to the presence of high amounts of polyunsaturated fatty acids, these products are prone to spoilage due to lipid oxidation, which reduces their quality. Considering that the rate of lipid and protein oxidation and the

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amount of products formed as a result of oxidation depends on the type of antioxidant used, it can be said that BHT was effective in postponing oxidative reactions. [24]. The determination of peroxides in fatty products is not reliable because the peroxides that are initially formed are volatile and react rapidly to form secondary products of lipid oxidation. The amount of thiobarbituric acid indicates the progress of oxidation and the formation of secondary oxidation products. The lower amount of TBARS in meatballs may be due to the washing process followed by the reduction of carbonyl compounds in the secondary fat oxidation step. Also, this step involves the washing of sarcoplasmic proteins, pigments, enzymes, blood, fats, flavor components, and minerals, so it is considered a reason for reducing fat oxidation in meatballs. [25]. The production of minced meat from fish accelerates the oxidation of lipids, but due to the fact that antioxidants were used in the processing of minced meat, the progress of fat oxidation was prevented. Kunyaboon and colleagues (2021) The lipid oxidation changes of silver carp minced meat were investigated. These researchers stated that thiobarbituric acid reached from 0.59 to 0.86 mg of malondialdehyde/kg, which is lower compared to the results of the present study in meatball and minced meat treatments (1.67 and 1.89 mg of malondialdehyde/kg). [23]. Ozalp Ozen and Soy (2018) when examining mackerel pollinated meat (Scomber scombrus) processed with 0.01 percent BHT During six months of storage in freezing, they found that peroxide increased from 1.80 to 5 mg/kg of fat and thiobarbituric acid from 2.88 to 5.33 mg of malondialdehyde/kg. [9]. In the present study, these indicators were determined in the treatments of meatballs (1.29 mg/kg of fat and 1.67 mg of malondialdehyde/kg) and minced meat (1.39 mg/kg of fat and 1.89 mg of malondialdehyde/kg), which is more compared to the results of recent studies. Fish species, water activity, amount of salt, antioxidants, number of bacteria and storage temperature are among the factors affecting the difference in the results of these studies with the present study.

Also, the measurement of volatile compounds such as total volatile nitrogen is considered an acceptable indicator for determining the spoilage of fish meat, and it shows the amount of decomposition of proteins into non-protein nitrogen compounds due to bacterial and enzymatic activity, and leads to the production of amines. [26]. Given that 25 mg/100 g TVB-N accepted in fishery products, in the present study this index was of favorable quality until the end of the storage time in the treatments of kofte (13.53 mg/100 g) and minced meat (14.25 mg/100 g) (Table 2). The low amount of TVB-N in meatballs may be due to partial removal of free amino acids, sarcoplasmic protein or non-protein nitrogen compounds by washing and dewatering. It is noteworthy that non-protein nitrogen is soluble in water and comprises 9-18% of the total nitrogen in fish muscle. But in minced meat, tissue protease enzyme provides the decomposition of protein compounds and increases the total of volatile nitrogenous bases. Nervous et al. (2014) TVB-N Original Content Anchovy Fish Meatballs (Engraulis encrasicolus) determined after frying. This amount reached 13.66 mg/100 grams at the end of the 5-month storage period [27], which is consistent with the results of the present study.Smoke and Pexzer(b2016) stated that the sum of volatile nitrogen bases in fish balls Alburnus of Mosul During six months of storage in freezing, it reached 26.9 mg/100 grams [28]. In the current study, the amount of this index in meatballs was 13.53 milligrams per 100 grams and in minced meat 14.25 milligrams per 100 grams, which is not the same as the results of the recent study. The observed difference can be related to the number of bacteria, protease enzymes, storage temperature and fish species.

pH is an important characteristic to evaluate the freshness of seafood and its products, which affects the color and textural properties of the meat of the product. Considering that pH in the range of 7 is

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acceptable for marine products, and this index was determined in the treatments of meatballs and minced meat: 6.92 and 6.89. (Table 2)Therefore, in the present study, this index was of favorable quality in the investigated treatments until the end of the cold storage period. pH is a factor that is affected by the bacterial load, total volatile nitrogenous bases, protein and protease enzymes, which were acceptable in meatball and minced meat treatments. In addition, in the meatballs, the presence of the washing step caused the water-soluble proteins and enzymes to be removed, which is a reason for preventing the increase in pH. In minced meat, the tissue protease enzyme remains active during freezing and causes the progress of protein oxidation and its decomposition, which results in the increase of hydrogen ions and pH. [29]. The lilac et al. (2024) evaluated the pH in panga fish balls prepared with 1% moringa leaf powder during 15 days of storage at 4 degrees Celsius. These researchers found the pH values of fish meatballs between 6.61 – They reported 6/56 [5], which is similar to the results of the present study.

In the study of sensory characteristics including texture (3/24-3/72), smell, color and taste In the treatments of minced meat and meatballs, they had good quality until the end of the storage time in the cold storage (Table 3). Because the oxidation of lipid compounds did not occur to a significant extent, which leads to a decrease in sensory characteristics and a change in the color of meatballs and minced meat during storage. Because the storage temperature is the most important factor determining the processes of lipid hydrolysis and oxidation, and the lipolytic rate decreases at low temperatures due to the inhibition of tissue enzymatic activity and enzymes released from bacteria. [30]. Also, due to the removal of water-soluble proteins and enzymes, color The meatball becomes lighter and its smell decreases. In addition to preserving the color, reducing oxidation is a factor that is one of its consequences such as The resulting spiciness prevented the formation of free radicals and their effects on the taste change in the experimental products [31]. garlic, onion and spices (Cinnamon, pepper, cloves, mustard) used to produce minced meat and meatballs act as flavoring. Due to the fact that sorbitol is a relatively sweet sugar, the sweet taste was not observed in the meatball treatment. In addition, monosodium glutamate used in the production of meatballs is also flavoring and effective in improving the taste of meatballs. Also, the smell and taste of fresh fish is slightly lost during grinding. Also, the washing step used to produce meatballs and that Heat treatment is a prerequisite for the production of meatballs, which helps to bring about favorable changes in texture, color, taste and smell [2]. Texture is one of the important characteristics of seafood. Meatballs and minced fish are made of fillers such as oil and water, which help make their texture juicy. After boiling in water, the fish meatballs reach an elastic and pleasant texture that can hide the smell of fish. [21]. One of the compounds used to produce kufte is modified starch. This combination It has many uses, which has become popular among consumers all over the world. Modified starch is a factor that can improve the texture of fish meatballs and make it resistant to the formation of ice crystals, because ice crystals are the ones that cause damage to the texture of the product during freezing. [32]. In this way, starch can increase the texture quality of the meatballs and extend the shelf life of the meatballs. Also, this combination increases the ability of fish meat to retain water, and less water is needed to create a smooth dough. It can also help the adhesion of the ingredients of the product, the stability of the product during freezing, melting, cooking and maintaining more moisture and flavor during cooking or reheating. In addition Starch increases the elasticity of the fish dumpling dough and causes it to stretch and expand during cooking, which is effective for improving the texture of the dumpling. It also gives the final product a smooth and shiny appearance. Since starch is gluten-free, it works as a good

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option for people who are sensitive to gluten [33]. in minced meat Polyphosphate creates a good texture in the product by swelling the protein and its water binding properties. In addition_Low levels of polyphosphate in combination with salt are effective for juiciness and softness of tissue and increase stability [22]. Yusuf et al. (2023) determined the scores of appearance, taste and texture indicators in catfish meatballs during 30 days storage in freezing, respectively 7, 6.7 and 6.3 [3]. The lilac et al. (2024) evaluated the sensory properties of panga fish meatballs prepared with 1% moringa leaf powder during 15 days of storage at 4 degrees Celsius. Overall acceptance was 7/5 [5]. In the present study, the score of this index is 3.90 – 3/39 was evaluated. Budiadnyani et al. (2022) star-shaped meatballs from fish surimi Swangi (Priacanthus tayenus) prepared and stated that the points of appearance (7), smell (7), taste (7) and texture (8) were acceptable. [1]., in the treatment of meatballs and minced meat in the present study, texture characteristics (3/72 – 24/3), taste (80/3 – 42/3), was (10/4). – 52/3) was determined. The results of these studies are similar to the results of the present study. Feng et al. (2017) used enzyme (0.4%) to produce meatballs with soft texture golden pomfret (Trachinotus blockii) using Bromelain solution was checked. Treatment with bromelain significantly reduced toughness because bromelain degraded myosin and troponin light chains, reduced the size of protein fragments, and thus improved meat tenderness. [34] In the present study, the meatball texture was of good quality, because oil and starch were used in the meatball ingredients, which made the texture soft and improved.

One of the criteria for checking the quality of food products is the quantity of pathogenic bacteria and spoilage agents. In the experimental treatments, the microbial characteristics were of favorable quality until the end of the storage time in the cold storage. Considering that the maximum number allowed for the total number of bacteria and Staphylococcus bacteria in marine products is 7 and 3 logarithmic colony-forming units per gram, and in meatball and minced meat treatments, the total number of bacteria (1.75 – 1.53 logarithm of colony forming unit per gram) and Staphylococcus (1.26 – 1.05 logarithm of colony forming unit per gram) were determined, so these treatments were microbially acceptable (Table 4). The high content of protein and moisture in fish meat makes minced meat and meatballs prepared from it susceptible to the growth of microorganisms. Therefore, these products are perishable and have different shelf life based on the amount of processing and the inclusion of additives such as different spices, garlic and onions. The effect of some spices such as cinnamon, cloves and mustard on the activity of microorganisms is very significant and their inhibitory effect on these microscopic organisms is well known. The antimicrobial effect of spices depends on the presence of ester, aldehyde, terpene and ketone compounds. There is approximately 17% essential oil in the clove bud, of which 93-95% is eugenone, which makes it more inhibiting and bacteriostatic than other spices. The inhibitory effect of cloves on molds and yeasts has also been proven. Onion and garlic also have a good antimicrobial effect on the activity of microorganisms [35]. Staphylococcus bacteria ability to work at 18 temperature – degrees Celsius, of course, this ability is relative and as can be seen in the results (Table 4), these bacteria disappear after 3 months. Considering the fact that fish meat is sterile before processing and that heat treatment is used to prepare meatballs and considering that Heat-resistant bacteria can survive this process. It can be said that the bacteria observed in the treatments entered the product during processing and especially packaging [36]. But keeping the treatments at a temperature of 18 – Celsius degree prevents the growth and activity of microorganisms. On the other hand, due to the decrease in temperature and freezing, there are changes in the food material in

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terms of physical and chemical characteristics such as water activity, pH, osmotic pressure and the production of ice crystals in the cell, which has an important destructive effect on the activity of microorganisms. In addition, due to the transformation of water molecules into ice particles, the viscosity of the environment changes, which causes changes in cellular proteins and the separation of lipoproteins, and as a result, microorganisms are destroyed. [37 and 38]. in minced meat Polyphosphates chelate essential structural metals such as calcium and magnesium ions of the cell wall, which leads to bactericidal and bacteriolytic effects. These metals probably form cross-bridges between teichoic acid chains in the cell wall of gram-positive bacteria. In addition, the antibacterial property of polyphosphate has been proven against Staphylococcus, Escherichia coli and Pseudomonas. Also, polyphosphate may inhibit the formation of bacterial biofilm [39]. Yusuf et al. (2023) found the total number of bacteria in frozen catfish meatballs to be 10^4 ×09/1 – 10^7 They determined 3.32 colony forming units per gram during 30 days of storage [3], which is more compared to the results of the present study. These investigators did not determine Staphylococcus in the meatballs, and Escherichia coli determined 14.7 logarithmic colony-forming units per gram, but in experimental treatments Staphylococcus (1.26 – 1.05 logarithm of colony forming unit per gram) was observed, but coliform and Escherichia coli were not observed. The difference in the results of this study with the recent study may be due to processing conditions such as equipment and water, compounds used for processing, fish transport and habitat.

5-Conclusion

Minced meat and Sim fish meatballs had favorable microbial, chemical, sensory and physical characteristics during storage for six months in cold storage. Therefore, the preparation of minced meat and meatballs from wire fish is suggested to the food industry.

6-Resources

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تهیه کوفته و گوشت چرخ کرده از ماهی سیم سد ارس (*Abramis barama*) و ارزیابی کیفیت و زمان ماندگاری آن ها در انجماد

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چکیده

ماهی سیم سد ارس به دلایلی مانند جثه کوچک، بوی نامطبوع و استخوان فراوان به شکل تازه‌خوری مصرف چندانی ندارد. ماهی سیم بیش از ۱۰۰۰ تن از صید سالانه را در سد ارس به خود اختصاص می‌دهد، که به دلیل حجم بالای صید در زمان کوتاه و نگهداری و انتقال نامناسب حدود ۹۰ درصد از این ماهیان برای تولید پودر ماهی به کار می‌رود، بنابراین مطالعه حاضر با هدف تولید گوشت چرخ کرده و کوفته از این ماهیان، ارزیابی کیفیت شیمیایی، میکروبی و حسی و زمان ماندگاری آن‌ها در دمای انجماد انجام شد. تیمارها شامل گوشت چرخ کرده و کوفته بودند (۲ تیمار). برای عمل‌آوری گوشت چرخ کرده آنتی اکسیدان BHT ۰/۲ درصد به کار رفت. تیمارها شش ماه در ۱۸ oC – نگهداری گردیدند. در نمونه‌ها سالمونلا، سودوموناس، کلی‌فرم، اشریشیاکلی و کپک و مخمر مشاهده نشدند. در گوشت چرخ کرده و کوفته TVB-N (۱۴/۲۵– ۱۳/۵۳ mg/100g)، pH (۶/۹۲ – ۶/۸۹)، پراکسید (۱/۳۹ -۱/۲۹ meq/kg lipid)، TBARS(۱/۸۹ – ۱/۶۷ mg MDA/kg) و تعداد کلی باکتری‌ها (۱/۷۵ -۱/۵۳ logCFU/g) در پایان زمان نگهداری قابل پذیرش بودند. در این تیمارها استافیلوکوکوس بعد از دو ماه نگهداری مشاهده نشد. در تیمارهای کوفته و گوشت چرخ کرده ویژگی‌های حسی شامل بافت (۳/۷۲ – ۳/۲۴)، بو (۴/۱۰ – ۳/۵۲)، رنگ (۳/۶۸ – ۳/۱۵)، طعم و مزه (۳/۸۰ – ۳/۴۲) و پذیرش کلی (۳/۹۰ – ۳/۳۹) از کیفیت مطلوبی برخوردار بودند. در تیمارهای کوفته و گوشت چرخ کرده رطوبت (۷۳/۲۶ – ۶۹/۱۲ درصد)، پروتئین (۱۹/۱۲ – ۱۷ /۲۴ درصد)، چربی (۴/۸۵ -۴/۷۱ درصد) و خاکستر (۱/۵۲ – ۱/۰۱ درصد) بودند. با توجه به این‌که ارزش غذایی در تیمارهای مورد بررسی از میزان بالایی برخوردار بودند، و در پایان زمان نگهداری ویژگی‌های شیمیایی، میکروبی و حسی قابل پذیرش تعیین گردیدند، بنابراین تهیه کوفته و گوشت چرخ کرده از ماهی سیم به صنعت غذایی پیشنهاد می‌شود.