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The preservative roles of barley extract on physico-chemical treats of common carp (*Cyprinus carpio* L.) fillets under refrigerated condition

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Abstract The study was carried out to determine the effect of barley extract on the shelf life of common carp fillets that refrigerated at 4°C through thiobarbituric acid (TBA), pH, water holding capacity, moisture contents and cooking loss. Using of thiobarbituric acid proved suitable for studying lipid hydrolysis and primary and secondary lipid oxidation in samples of common carp throughout refrigerated storage. Barley powder extract solutions (water extraction) were prepared at the concentration of 0.5%, 1% and 1.5 % (v/v), also, control without adding barley extract. The samples were then stored under refrigerated conditions (4.0°C) for 0, 3 and 6 days until analysis. The results confirmed the efficacy of natural antioxidants derived from barley slowing down lipid hydrolysis and increasing the oxidative stability of common carp flesh.

Keywords: Barley, Antioxidant, Shelf-life, Common carp, Extract, Thiobarbituric acid

INTRODUCTION

Fish also generally been known to be one of the basic forms of animal nutrition, and if it was not because of the fragile nature of fish bones, archaeology would rate fish more strongly in prehistoric nutrition lists. Fish is a healthy source of nutrition, polyunsaturated fatty acids (PUFAs), essential nutrients for human food (Venugopal & Shahidi 1995). Fish possess significant concentrations of polyunsaturated fatty acids (PUFA), several of which eicosapentaenoic acid and docosahexaenoic acid are perhaps the most common (Ackman 1989). PUFAs are considered to be significantly prone to peroxidation and also to be easily integrated into the lipid peroxidation process to produce reactive oxygen species and lipid peroxy radicals (Hsieh & Kinsella 1989; Porter et al. 1995).

Another big barrier to the use of fish is that they have been particularly vulnerable to oxidation attributed to the prevalence of PUFA. Lipid oxidation can lead to bad odour, rancid taste and discoloration. Regulation of oxidation of fats/oils and lipid-containing substances can be accomplished which exclude initiators and promoters during production and packaging (Frankel, 2005).

Natural antioxidants have traditionally been found healthy for consumer use as well as possible damage to people has still not been properly examined. There has been mounting evidence that care must be practised while determining the protection of natural antioxidants (Frankel, 2007).

Barley (*Hordeum vulgare*), which is one of the five major crops worldwide, together with rice, wheat, corn and soya, is sources of vitamin B classes, nutrients and carbohydrates, and also unsolvable and insoluble dietary fibre (Arora et al. 2010). Dietary intake fibre in barley varies between 11% and 34%. Barley-contained β-glucan has

attracted considerable interest due to its versatility (Izydorczyk et al. 2000), and has been reported to have positive health benefits, such as the reduction of blood cholesterol and glycemic index modulation in the human body (Regand et al. 2009; Wolever et al. 2010).

There is also a strong trend towards eliminating any use of antioxidant compounds in food production with the use of natural oxidation inhibitors or the preferred use of ingredients that naturally have antioxidant activity, so the main goal of this research was to determine whether such addition of natural scarcely powders could delay lipid and protein oxidation and enhance the efficacy of co-oxidation. In addition, this analysis gives significant insight into the ability of barley powder as a safe and efficient source of antioxidants for fish products.

MATERIALS AND METHODS

Materials

Barley powders (not oxidized and clear from any insects) were purchased from a local traditional market in Sulaimani.

Preparation of plant extracts

In the case of the water extract, 50 g of barley powder was mixed with 500 ml of boiled distilled water in a sealed container and kept at room temperature for 24 hours with continuous shaking; the extract was then purified through Whatman No. 1 filter paper. A separate container was used to collect the extract. The filtrates were concentrated using a soxhlet apparatus, and the extracts were freeze-dried and deposited in sealed bottles at 4 °C before use. As a natural antioxidant, these extracts were used.

Preparation of fish sample

Common carp (*Cyprinus carpio* L.) were purchased from a local market and were transported alive to the laboratory. The fresh common carp were slaughtered, scaled, gutted and washed in cold water and filleted, then packed in polyethylene bags and stored in the refrigerator at 4 °C for 24 hours. After 24- hours chilling fish filets were taken out of refrigerator and cut in to pieces of the same size (3×3×3 cm), and were randomly allocated for four (4) treatments:

Fish samples were immersed in 100 ml of antioxidants solution at concentration of 0% (Control) (T1), 0.5% (T2), %1 (T3) and 1.5% (T4) of barely powder respectively, then left at room temperature for one hour, samples were removed from antioxidant solutions, packed in polyethylene bags, stored in refrigeration at 4°C for 48 hours, then kept in freezing at -18 °C until analysis.

Treatments

The study included four treatments in which three levels of each of barley, used as below.

T1: (control) without any addition
T2: barely (0.5%)
T3: barely (1%)
T4: barely (1.5%)

Cooking loss

Cooking loss was measured according to Cyril *et a*l. (1996), 20 g of fish flesh were placed in open aluminium foil and cooked for 15 minutes in the oven , pre-heated to 200 °C, after cooking, the samples were dried with a paper towel (cooled for 30 min to15 °C). Total cooking loss was estimated on each sample as a percentage ratio between cooked and raw weight.

Water Holding Capacity (WHC)

Water holding capacity (WHC) was measured according to Wardlaw et al. (1973), About 4 g of fish flesh was mixed with 6 mL of NaCl (0.6 M) in a test tube and incubated at 5 °C for 15 min. The test tubes were then centrifuged at 4100 rpm for 15 min. The WHC (mL/100g meat sample) was calculated in the resulting supernatants.

$$\text{WHC\%} = \frac{\text{Initial volume} - \text{volume of supernatant}}{\text{Intitial volume}} \times 100$$

Note: CF is centrifugation.

Thiobarbituric acid (TBA) value analysis

Thiobarbituric acid (TBA) was analyzed according to Tarladgis et al. (1960) as adopted by Witte et al. (1970), TBA values were expressed as mg malonaldehyde/ kg. A 2 gram of fish flesh was prepared by mixing in 5 mL of extraction solution containing 20% TCA previously prepared in 2 M phosphoric acid. Filtered through Whatman No. 1 filter paper; 5 ml of filtrate was transferred to the

test tube followed by the addition of 5 mL of Thiobarbituric acid (0.005 M in distilled water) and kept in a dark place for 15-17 hour at room temperature. The resulting colour was measured at 530 nm using UV spectrophotometer (Shimadzu, Japan). TBA values were calculated by multiplying the absorbance value of the sample by 5.2.

Moisture content

A 5 g of fish fillet was left in an incubator for 24h after that the moisture content was measured according to the AOAC 2000 method.

Statistical analysis

The XL Stat program for Windows was used to study factors examined (treatment and period) in traits. Duncan multiple ranges were used to significantly compare between means (0.05) (Steel et al. 1996).

RESULTS AND DISCUSSION

Cooking loss

There was no significant difference in cooking loss among treatments on day 0. On the other hand, significant variations were observed between T4 other treatments on day 6. The highest cooking loss value was at day 6 for T1 (%48.590±0.719). While the lowest cooking loss value was on day 6 for T4 (%34.537± 0.749). Overall, the values of cooking loss were increased with increasing period of storage. This finding in the present study is confirmed by Wang (2000), Al-Haju (2005) and Gorge (2000), who reported that the more storage time the more cooking loss of the samples was observed. This was due to several factors that could affect the loss of weight through loss of meat juice or drips, water evaporation, evaporation of volatile materials, some nutritious elements loss, extracting of meat juice due to cooking shrinkage and loss of water-soluble nutritional element.

Table 1 Effect of different levels of barley extract on cooking loss (%) values of fresh common carp (*C. carpio*) fillets during storage at 4 °C for 6 days.

		Cooking loss (CL)%		
		Storage time (day)		
Treatments		0	3	6
control	T1	36.377± 0.67 ^{ef}	46.260±0.69 ^{a}	48.590±0.71 ^{a}
0.5%	T2	36.56± 0.616 ^{ef}	40.063± 1.111 ^{bc}	42.133±1.095 ^{b}
1%	T3	37.08±0.794 ^{def}	38.433 ±0.622 ^{cde}	39.693±1.41 ^{bcd}
1.5%	T4	34.537±0.749 ^{f}	36.923±0.845 ^{def}	37.360± 0.771 ^{cdef}

For each parameter, mean values (n=3) followed by different letters (a, b, c, d, e) denote significant differences ($p < 0.05$) for each time between T1, T2, T3 and T4 samples.

Water holding capacity

On day 0 there was a significant difference between T1 with T2, T3 and T4. The results of the water holding capacity (WHC) percentage was shown in table 2. After 3 days, the results showed that there was a significant difference among treatment 1 compared with other treatments. On day 6, there was no significant difference between T2 and T3, while T4 differed significantly with T1, T2 and T3 ($P \leq 0.05$). The highest percentage of WHC was recorded in T4 (45.03±0.967 %) while the lowest percentage was recorded in T2 (36.00±0.578 %). Measuring the ratio of WHC and cooking loss could be good parameters to detect the quality of meat via denaturation of protein (Skipnes et al. 2007). It may possibly be due to the role of barley powder extract may protect fish tissues from lipid oxidation and protein denaturation, this might binding water and increasing water holding capacity and less drip which led to increasing ability of meat tissues to retain water and decreasing moisture loss during storage and cooking (Arora, 2000).

Table 2 Effect of different levels of barley extract on water holding capacity (%) values of fresh common carp (*C. carpio*) fillets during storage at 4 ºC for 6 days.

		Water holding capacity (WHC) %		
		Storage time (day)		
Treatments		0	3	6
control	T1	40.59± 0.521 ^{de}	38.497±0.287 ^{ef}	36.08±0.140 ^{g}
0.5%	T2	41.45± 0.373 ^{dc}	39.403±0.705 ^{e}	36.00± 0.578 ^{g}
1%	T3	44.190± 0.405^{ab}	40.090± 0.669 ^{e}	37687± 0.72 ^{fg}
1.5%	T4	45.03± 0.967 ^{a}	43.250± 0.230 ^{bc}	40.487± 0.497 ^{de}

For each parameter, mean values (n=3) followed by different letters (a, b, c, d, e, f, g) denote significant differences ($p < 0.05$) for each time between T1, T2, T3 and T4 samples.

Thiobarbituric acid (TBA) value analysis

A constant increase in the values of thiobarbituric acid (TBA) was observed in the fish samples (Table 3). There was no significant ($p \leq 0.05$) difference among treatments on day 0. On day 6 there was a significant difference ($p \leq 0.05$) between T1 with treatment (2,3,4). The highest TBA value that was recorded in this study was in T1 on day 6 (2.340± 0.01), while the lowest value was in T3 on day 0 (0.483±0.029). Thiobarbituric acid reactive substances can be degraded or interact with other components, such as proteins, to form polymers that decrease the quality of salmon (Fernandez, Perez-Alvarez & Fernandez-Lopez 1997; Goulas & Kontominas 2007; Pournis, Papavergou, Badeka, Kontominas & Savvaidis 2005; Ruiz-Capillas, Morales & Moral 2001). Lipids and proteins do not react to form complexes unless the fat or fatty acids are oxidized (Bhattacharya, Sajilata & Singhal 2008).

Table 3 Effect of different levels of barley extract on TBA values of fresh common carp (*C. carpio*) fillets during storage at 4 ºC for 6 days.

		TBA values		
		Storage time (day)		
Treatments		0	3	6
control	T1	0.607 ± 0.012 ^{d}	1.140± 0.38 ^{bcd}	2.340±0.01^{a}
0.5%	T2	0.600±0.020 ^{d}	1.160±0.111 ^{bcd}	1.310 ±0.583 ^{bc}
1%	T3	0.483± 0.029 ^{d}	0.637± 0.035 ^{cd}	1.360± 0.02 ^{b}
1.5%	T4	0.563± 0.41 ^{d}	0.577± 0.012 ^{d}	1.140± 0.144 ^{bcd}

For each parameter, mean values (n=3) followed by different letters (a, b, c, d, e) denote significant differences ($p < 0.05$) for each time between T1, T2, T3 and T4 samples.

pH

There was no significant ($p \leq 0.05$) difference between treatments on day 0. On day 3 T1 different significantly ($p \leq 0.05$) among other treatments, while non-significant differences were found between T3 and T4 as shown in table (4). Also, T2 differ significantly ($p \leq 0.05$) with T1 and T3. In the periods (6 days after storage), there were no significant differences among treatments in pH of fish meat. T1 recorded the highest pH value (6.579± 0.192) on day 6 of storage while the lowest value in T2 (5.722±0.010) on day 6. Up to the sixth day of storage increases in pH may be attributed to the production of volatile base compounds by bacterial activity (Cann et al. 1983).

Table 4 Effect of different levels of barley extract on pH values of fresh common carp (*C. carpio*) fillets during storage at 4 ºC for 6 days.

		pH values		
		Storage time (day)		
Treatments		0	3	6
control	T1	6.223 ±0.008 ^{bc}	6.268 ±0.041 ^{bc}	6.117±0.095^{cd}
0.5%	T2	6.210±0.023 ^{bc}	5.722±0.010 ^{f}	6.579± 0.192 ^{a}
1%	T3	6.130±0.047 ^{cd}	5.92±0.0110 ^{de}	6.435±0.020 ^{ab}
1.5%	T4	6.147±0.008 ^{cd}	5.858± 0.03 ^{ef}	6.411± 0.022 ^{a}

For each parameter, mean values (n=3) followed by different letters (a, b, c, d, e, f) denote significant differences ($p < 0.05$) for each time between T1, T2, T3 and T4 samples.

Moisture content

Mean values for moisture percentage were represented in table 5. There was no significant ($p < 0.05$) difference among treatments on day 0. On day 3, also not significant differences were noted ($p < 0.05$) among treatments. In the last period (day 6), T3 significantly differ ($p < 0.05$) with T2 and T4. The highest percentage of moisture was observed in T3 on day 0 (77.123± 1.030), while the lowest record in T4 on day 6 (68.523± 1.113).

Table 5 Effect of different concentrations of barley powder on moisture content of fresh common carp (*C. carpio*) fillets during storage at 4 ºC for 6 days.

		Moisture content		
		Storage time (day)		
Treatments		0	3	6
control	T1	76.307±1.212 ^{a}	73.18±0.438 ^{bc}	71.647 ±1.090 ^{cd}
0.5%	T2	75.61±0.633 ^{ab}	72.377±0.646 ^{c}	69.393±0.631 ^{de}
1%	T3	77.123±1.030 ^{a}	73.107± ^{bc}	71.920±0.538 ^{cd}
1.5%	T4	75.967±0.831 ^{a}	70.910± 0.773 ^{cde}	68.523± 1.113 ^{e}

For each parameter, mean values (n=3) followed by different letters (a, b, c, d, e) denote significant differences ($p < 0.05$) for each time between T1, T2, T3 and T4 samples.

CONCLUSION

In conclusion, extracts from barley that was used in this experiment revealed good antioxidant and antibacterial properties, throughout these results barely powder could be used in fish and its products and extending shelf life.

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