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The Use of Dietary Enrichment with Lemon Pomace Powder for the Prevention of Lipid and Protein Oxidation in Carp during Storage at Refrigerator

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Abstract

The aim of this study was to evaluate the effect of dietary enrichment with lemon pomace powder on lipid and protein oxidation of carp fillets during storage at refrigerator. Group 1 of carps as control group was fed with basic diet and groups 2, 3 and 4 were fed with 1.5, 3 and 5% lemon pomace powders, respectively. After the end of the study (4 weeks), 10 fish from each group were randomly captured and stored at 4 °C for 3 days. At the capture time and during storage times, 24, 48 and 72 hours at refrigerator, lipid and protein oxidation parameters of the muscle were evaluated. The results indicated a significant difference in the mentioned indices in group 4 compared to other groups ($P<0.05$). Therefore, a diet containing 5% lemon pomace powder is suggested as a natural antioxidant in carp diet to improve the oxidative status and increase the shelf life of the fillet during storage at 4 °C.

Keywords: Carp, Lemon pomace powder, Lipid, Protein oxidation

Introduction

Tissues of fish contain a high level of poly unsaturated fatty acids; therefore, they are so susceptible to lipid and protein oxidation reactions (Alibeyghi, Alizadeh Doughikollae, & Zakipour Rahim Abadi, 2013). Oxidative Processes in meat are the most important factors responsible for quality deterioration which can influence shelf-life of meat (Ghanei-Motlagh, 2013). Formation of free radicals and antioxidant defense is in a balance, and oxidative damage occurs as a result of an imbalance between the formation of free radicals and neutralization through antioxidant mechanisms (Rashidnejad, Shahsavani, & Baghshani, 2018).

Some recent studies have shown that the use of natural antioxidants with herbal sources are more suitable than synthetic antioxidants to reduce oxidative damage in foods (Devasagayam *et al.*, 2004). Lemon is a natural antioxidant which has high nutritional value as well as some health-related beneficial impacts (Mcharek & Hanchi, 2017). Lemon compounds play an important role to improve antioxidant conditions of meat (Nobakht & Amiridashatan, 2013).

Measurement of malondialdehyde (lipid oxidation biomarker) and carbonyl groups (protein oxidation biomarkers) can be used as appropriate indices of oxidative processes (Rumley & Paterson, 1998). The aim of this study was to investigate the possible role of dietary lemon pomace powder in preventing oxidation of lipids and proteins in carp meat during different storage times at refrigerator.

Material and methods

Experimental design

120 carps (approximately 60 g) were randomly divided into 4 groups of 30. The first group as control group, was fed with basic diet and groups 2, 3, and 4 were fed with 1.5, 3 and 5% lemon pomace powders, respectively. After the end of 4 weeks, 10 fish from each group were randomly captured and stored at 4 °C for 3 days. At the capture time and during storage times at refrigerator (24, 48 and 72 h after catch) muscle sampling was done for evaluation of lipid and protein oxidation parameters.

Tissue preparation and analytical methods

Tissue samples were blended with 1:10 (w/v) phosphate buffer (0.05 M, pH=7.4) and were homogenized by homogenizer. Then they were centrifuged (4.000 g for 15 min), and the supernatant was used to measure different parameters.

Malondialdehyde (MDA), as the lipid peroxidation indicator, was assayed based on its reaction with thiobarbituric acid as described by (Latha & Pari, 2003). MDA reacts with two thiobarbituric acid molecules and yields a reddish compound. A molar absorption coefficient of $156000 \text{ M}^{-1}\text{cm}^{-1}$ was used to calculate the concentration. Carbonyl groups of proteins, as an indicator for protein oxidation, was measured based on reaction with 2, 4-dinitrophenylhydrazine as described by (Jiang *et al.*, 2010).

Statistical analysis

All experimental values were represented as mean±standard error of the mean. All results were analyzed using one way analysis of variance followed by Duncan post hoc test for multiple comparisons. The level of significance was set at ($P<0.05$). All calculations were performed using SPSS/PC software.

Results and discussion

The results of evaluated parameters in this study are shown in Tables (1) and (2). According to the current study, after consumption of lemon pomace powder, MDA level of the muscles in group 3 was significantly lower compared to group 2 and control group ($P<0.05$). MDA level in group 4 was considerably lower at the capture time and also 24, 48 and 72 h later in refrigerator as compared to other groups (Table 1).

Table 1. MDA content ($\mu\text{mol/L}$) in carp meat at the capture time and during storage times at 4 °C

Group	lemon pomace powder (%)	capture time	24 h after catch	48 h after catch	72 h after catch
1 (control group)	0	0.33 ^a	0.67 ^c	0.18 ^{df}	0.17 ^f
2	1.5	0.23 ^b	0.60 ^c	0.34 ^{ab}	0.28 ^b
3	3	0.17 ^{bf}	0.16 ^{bf}	0.22 ^{bd}	0.21 ^{dg}
4	5	0.21 ^{bd}	0.23 ^{bd}	0.10 ^{ef}	0.09 ^e

The values of protein carbonyls in groups 3 and 4 was significantly lower in comparison to group 2 and control group at the capture time and also 24, 48 and 72 h later in refrigerator (Table 2). Taken together, the results indicated a significant difference in the mentioned indices in group receiving 5% lemon pomace powder compared to other groups.

Table 2. Protein carbonyls content ($\mu\text{mol/mL}$) in carp meat at the capture time and during storage times at 4 °C

Group	lemon pomace powder (%)	capture time	24 h after catch	48 h after catch	72 h after catch
1 (control group)	0	5.41 ^a	8.04 ^c	9.08 ^c	10.38 ^c
2	1.5	4.51 ^a	7.93 ^c	9.39 ^c	10.05 ^c
3	3	2.32 ^b	4.05 ^{ad}	4.89 ^{af}	6.65 ^g
4	5	1.72 ^b	1.93 ^{be}	4.03 ^{af}	6.58 ^{afg}

Conclusion

The current study suggested that lemon pomace powder as a natural antioxidant, was effective in improving oxidative state of muscle tissue of common carp by reducing lipid and protein oxidation and increasing the shelf life of the fillet during storage times at 4 °C. Therefore, a diet containing 5% lemon pomace powder is suggested as a natural antioxidant in carp diet to improve the oxidative status and increase the shelf life of the fillet during storage at 4 °C.

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