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THE QUALITY OF RAINBOW TROUT FILLETS AS AFFECTED BY FEEDING FISH DIFFERENT DIETARY FORMULATIONS

H. W. OCKERMAN[1], T. LESIOW[2] and K. DABROWSKI[3]
DEPARTMENT OF ANIMAL SCIENCE[1] & SCHOOL OF NATURAL RESOURCES[3], THE OHIO STATE UNIVERSITY, COLUMBUS, OHIO 43210, USA, AND DEPARTMENT OF ANIMAL FOOD TECHNOLOGY[2], THE ACADEMY OF ECONOMICS, 53-345 WROCLAW, POLAND

The utilization of by-products as the dietary ingredients for animals and poultry is limited by its influence on the sensory quality of meat. There is little information available concerning the influence of diets used during raising fish and storage time of their fillet on functional and sensory properties of fish.

Rounds at al.(1992) compared consumer acceptance of brown and rainbow trout and found that both species were accepted and acceptability depended on an interaction between species and the water in which they were grown. Bakir at al.(1993) examined the influence of different diets on lipids and sensory characteristics of white amur. Chambers at al.(1993) compared sensory properties among fresh water fish species. Smith et al.(1988) found no differences in flesh acceptability associated with trout strain or based on plant or animal protein diet. The objective of this study was to determine the effect of 5 diets formulated with different proportion of animal by-products supplement on functional and sensory characteristics of rainbow trout stored 24-48 h or 144-168 h on ice.

Materials and Methods

Rainbow trout of the "golden" variety were reared in 15 tanks (3 tanks per treatment) fitted with Venturi type drains and covered with netting. The water flow through the tanks was 5.27 l/min. Compressed air was also injected into each tank to help aerate and maintain dissolved oxygen levels at 8.0 ppm. The water temperature in each tank was maintained between 10 and 12°C throughout the experiment. Fish were fed for 4 months a control, fish meal-based diet or diets where 25, 50, 75 and 100% of the fish meal protein was replaced with an animal by-product mixture. Two fish were removed from each tank (a total of six fish per diet) and the head, viscera and skin were removed. The left fillets were stored 24-48 h and the right ones for 144-168 h in plastic bags on ice.

The pH of the fish tissue was determined following 10 g sample blending with 100 ml of distilled water for 1 min (Ockerman 1985). The pH determinations were made after 24 and 144 h post mortem with a pH meter. Water binding was determined at 48 and 168 h post mortem on 0.5 g samples pressed for 1 min at 500 psi using the filter paper press method of Wierbicki and Deatherage (1958). Total moisture was determined by the oven drying method (Ockerman

Table 1

Means of the functional properties and sensory characteristics of fillets from rainbow trout fed five different diets and stored 24-48 h or 144-168 h on ice.

Parameter	Time	Mean*	Replacement of Fish Meal 0%	25%	50%	75%	100%
pH	24h	5.35^{b}	6.62^{ab}	6.59^{abc}	6.55^{bcd}	6.47^{de}	6.45^{e}
	144h	5.88^{a}	6.67^{a}	6.63^{ab}	6.62^{ab}	6.55^{bcd}	6.51^{cde}
RF570 (outer)	48h	37.21^{a}	36.00^{c}	38.25^{abc}	36.45^{bc}	40.17^{a}	35.17^{c}
	168h	37.27^{a}	35.58^{c}	38.70^{abc}	35.25^{c}	39.80^{ab}	37.00^{abc}
RF650	48h	52.97^{a}	53.50^{bcd}	$53.28b^{cd}$	52.17^{bcd}	54.38^{ab}	51.50^{d}
	168h	53.90^{a}	54.08^{abcd}	54.17^{abc}	51.67^{cd}	56.17^{a}	53.42^{bcd}
RF650/RF570	48h	1.43^{a}	1.49^{ab}	1.40^{bc}	1.44^{abc}	1.36^{c}	1.47^{abc}
	168h	1.45^{a}	1.53^{a}	1.40^{bc}	1.47^{abc}	1.42^{abc}	1.43^{abc}
Bound water	48h	89.23^{a}	88.35^{c}	88.73^{bc}	90.94^{a}	89.16^{bc}	88.98^{bc}
	168h	89.19^{a}	89.03^{bc}	89.76^{abc}	90.35^{ab}	88.80^{bc}	88.01^{c}
SF	24h	1.01^{a}	1.06^{abc}	0.93^{bc}	1.01^{abc}	0.96^{abc}	1.10^{ab}
	144h	0.99^{a}	1.13^{a}	0.92^{c}	0.91^{c}	0.96^{abc}	1.02^{abc}
Work for	24h	6.55^{a}	6.63^{ab}	6.49^{ab}	6.42^{ab}	6.50^{ab}	6.72^{ab}
shear	144h	6.34^{a}	7.05^{a}	6.10^{b}	5.92^{b}	6.20^{b}	6.47^{ab}
Color	24h	5.35^{b}	5.46^{bc}	5.58^{bc}	4.63^{d}	5.88^{ab}	5.32^{c}
	144h	5.88^{a}	5.43^{bc}	6.11^{a}	5.39^{bc}	6.12^{a}	6.25^{a}
Flavor	24h	5.73^{b}	5.25^{c}	5.92^{ab}	5.63^{bc}	5.63^{bc}	6.20^{ab}
	144h	6.16^{a}	5.98^{ab}	6.19^{ab}	6.02^{ab}	6.38^{a}	6.14^{ab}
Juiciness	24h	5.98^{a}	5.90^{ab}	5.92^{ab}	5.98^{ab}	6.00^{ab}	6.08^{ab}
	144h	5.97^{a}	5.52^{b}	5.97^{ab}	6.01^{ab}	6.26^{a}	6.09^{ab}
Tenderness	24h	5.96^{b}	5.98^{ab}	5.76^{b}	5.92^{ab}	6.17^{ab}	5.98^{ab}
	144h	6.38^{a}	5.95^{ab}	6.42^{ab}	6.58^{a}	6.64^{a}	6.27^{ab}

Data in the row for each parameter with the same superscript are not significant ($P>0.05$)

* Mean is least square mean for 0 to 100% replacement diets

1985). The color of both sides of each fillet was evaluated using a Spectronic-20 reflectance attachment (Bausch and Lomb) at 570 nm and 650 nm. The ratio was calculated (650 nm/570 nm) after 48 and 168 h.

Sensory evaluation

Fillets were cooked in a preheated oven at 165°C for 25 min. to an internal temperature of 70°C. After cooling 15 min. samples were cut into 2 cm sections and were evaluated by 5-6 experienced judges. Each parameters was scored: color 1= dark, 9= light; texture 1= soft, 9= firm; flavor 1= strong, 9= no flavor; juiciness 1= dry, 9= juicy; tenderness 1= tough, 9= tender and overall acceptability 1= undesirable, 9= desirable (Connell 1971).

The shear strength was determined on the remaining part of the cooked fillet divided into four slices of 2 x 1.5 cm. The Instron Universal Testing Machine with Warner Bretzler test cell (Hsueh-Hing, 1986) was used. The shear force/strength (SF) measurements were recorded as the peak force (kg). The area below the curve was described as work to shear and was expressed in cm^2.

Analysis of variance was conducted using a split plot design with diet as a main effect and storage time as subplot effect by the GLM procedure(SAS Institute,Inc.,1988). Duncan's multiple comparison test was utilized to determine differences among the means.

Results and discussion

The functional properties after storage of fillets from 5 different diets and sensory characteristics are presented in Table 1.

No interaction was found between diet and time of storage. Diet did not influenced reflectance of the inner surface of fillets, texture (5.3-5.91), tenderness (5.76-6.64) or overall acceptability (6.3-6.88).

Storage time and diet significantly ($P<0.05$) affected pH. Diet significantly affected both reflectance of outer side, water binding and SF. The pH values of muscle tissue for each diet were higher after 144 h than after 24 h storage. The pH was lower when higher amounts of fish replacement were utilized in the diet. The pH of fillets of 0% diet replacement was significantly higher than of 75 and 100% replacement for both times of storage. Moreover samples of 25% and 50% diet replacement had higher values than 75 and 100% after 24 h and that of 100% replacement after 144 h. The diet and storage time did not have a noticeable effect on color of inner side of fillets although some changes were observed for outer color.

Water binding was the highest in muscles of 50% diet replacement and was significantly different from samples of all diets after 48 h and of 100% replacement after 168 h.

SF and work to shear recorded for cooked fillets from fish fed diets with 25 and 50% fish meal replacement were rated more tender after 144 h than those fed 0%.

Color, texture, flavor and tenderness were significantly higher after 144 h in comparison with 24 h (Table 1). Diet effected only color evaluation for the inner side which is usually displayed in the market. Fillets from fish fed with 50% replacement and stored 24 h as well as fish fed with 0 and 50% replacement and stored 144 h scored significantly lower in panel color compared with the fillets from the remaining diets.

Fish flavor was significantly stronger in fillets of 0% diet replacement fed fish after 24 h than in samples of 25 and 100%, and fillets of this diet were estimated as less juicy than fillets from diet with 75% replacement after 144 h.

Flavor and texture are the most important factors determining consumer acceptance (Sawyer 1988). In this study there were little textural differences among fillets of fish fed five diets and two storage times. While the flavor was found as not pronounced, color which is normally a neutral or negative factor (Hamilton 1983) can in the case of the golden rainbow trout play an important role in acceptance by consumer. Fillets of 25, 50 and 100% diet replacement were rated significantly higher in color and more acceptable after 144 h in comparison with 24 h.

Conclusions

In spite of the fact that fillets from fish fed diet with 50% replacement were rated as the lowest in color for both storage times, and fish fed the diet with 0% replacement had the strongest flavor after 24 h and were less juicy after 144 h, all treatments were evaluated by the sensory panel as being very satisfactory.

Fillets from fish fed diets with fish meal replacement by animal by-products were evaluated as acceptable and generally not significantly different from control samples.

References

Bakir, H.M, Melton, S.L. and Wilson, J.L. 1993. J. Food Sci. 58:90.
Chambers IV, E. and Robel, A. 1993. J.Food Sci. 58:508.
Connell, J.J. and Howgate, P.F. 1971. Consumer evaluation of fresh and frozen fish. In Fish Inspection and Quality Control, (Ed.) R.Kreuzer, p.155. Fishing News Books Ltd., London.
Hamilton, M. and Bennet, R. 1983. J.Food Technol. 18:75.
Hsueh-Ming Chow, Ockerman, H.W., Cahill, V.R. and Parrett, N.A. 1986. J.Food Sci. 51:288.
Ockerman, H.W. 1985. "Quality of Post Mortem Muscle Tissue". The Ohio State University, Columbus, OH.
Rounds, R.C., Glenn, C.L. and Bush, A.O. 1992. J.Food Sci. 57:572.
SAS Institute, Inc.1982. SAS User's Guide: Statistics. SAS Institute, Cary, NC.
Sawyer, F.M., Cardello, A.V. and Prell, P.A. 1988. J.Food Sci. 53:12.
Smith, R.R., Kincaid, H.L., Regenstein, J.M. and Rumsey, G.L. 1988. Aquaculture. 70:309.
Wierbicki, E. and Deatherage, F.E. 1958. J. of Agr.and Food Chem. 6:387.