THE EFFECT OF INCREASING UNREFINED FISH OIL LEVELS IN OSTRICH DIETS ON THE ORGANOLEPTIC AND FATTY ACID PROFILE OF THE *M. ILIOFIBULARIS.*

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Background

Oils are commonly added to ostrich diets as an economic means of producing energy-rich formulations and to prevent respiratory disease. Of all the different types of oil, unrefined fish oil is by the far the cheapest source of energy. Fish oil however has severe adverse effects in chickens when included in too high concentrations as part of the diet, due to the direct correlation between flavour and the percentage of fatty acids - eicosapentaenoic (C20:5), docosapentaenoic (C22:5) and docosahexaenoic (C22:6) in the diet (Miller *et al.*, 1969).

Objective

The research was done to determine whether off-flavors could be detected in ostrich meat when birds were fed diets containing various levels of fish oil.

Methods

Four groups of ostriches received various levels (D1=0 %, D2=0.6 %, D3=1.2 % and D4=1.8 % equivalent in a complete feed, based on the intake of 2 400 g DM/feed/day) of unrefined fish oil. The *M iliofibularis* and fat strips from the abdominal cavity of the ostrich were used for the sensory evaluation of the meat and was kept at <4 °C vacuum-packed for the two-week duration of the analysis. The meat was roasted in oven bags to an internal temperature of 73 °C at an oven temperature of 180 °C. The fat was roasted for 10 min in oven bags at a temperature of 180°C. The samples were presented to a trained panel of five to determine differences between the treatments with regards to the attributes aroma and flavor for both the fat and meat samples. Tenderness and juiciness evaluations (chewing and pressing between fingers) were only done on the meat samples. The evaluation was done by means of a 0-100 mm unstructured line scale.
The fatty acid analysis was done according to the preparation method of Folch *et al.* (1957) and Butte (1983) on a Hewlett Packard 5890 (series II) GC.
A factorial analysis of variance was performed on all data (SAS, 1990). Student's t-Least Significant Differences (LSD) was calculated at the 5% significance level to compare treatment means.

Results and discussions

Sensory evaluation showed that the panellists could not distinguish between the muscles from the different groups of ostriches regarding the attributes aroma and flavour (Table 1). The aroma and flavour mean values noted by the panel for the fat, however, show a significant difference between diet 3 (D3, 1.2% fish oil inclusion), diet 4 (D4, 1.8% fish oil inclusion) and the control (D1, 0% fish oil inclusion). The juiciness of the meat from the four different groups differs significantly with regards to juiciness as perceived through the pressing of the meat between the fingers. Juiciness as perceived in the mouth, however, showed no significant difference. No significant difference was also observed for tenderness.

Table 1. Mean values for sensory characteristics of ostrich meat and fat.

Samples	Attribute	Diets				
		D1 (0%)	D2 (0.6%)	D3 (1.2%)	D4 (1.8%)	LSD (P=0.05)
Meat	**Aroma**	9.79	13.32	12.20	13.67	9.74
	Flavour	4.92	7.21	9.38	7.59	5.51
	Juiciness-touch	44.24 ^{ab}	53.56 ^{a}	39.04 ^{b}	50.75 ^{ab}	13.78
	Juiciness-mouth	45.16	53.24	44.96	50.79	14.14
	Tenderness	60.12	56.76	61.24	61.00	11.76
Fat	**Aroma**	21.32 ^{a}	47.48 ^{b}	62.56 ^{bc}	65.80 ^{c}	17.448
	Flavour	22.00 ^{a}	37.12 ^{ab}	52.08 ^{bc}	65.60 ^{c}	17.457

a-c: Values in the same row with different superscripts differ significantly (P<0.05)

The predominant fatty acids in the meat and abdominal fat pads were palmitic (C16:0), oleic (C18:1), and linoleic (C18:2), with moderate amounts of stearic (C18:0), linolenic (C18:3-*n*3) and palmitoleic (C16:1). The percentages of saturated fatty acids (SFA) in the fat pads, were 50%, and that for the meat 40%. The SFA also increased with the increase in fish oil contents of the diets especially the fatty acids C16:0 and C14:0. In fish oil the C16:0 fatty acid is present in very high concentrations, together with C16:1, C18:1 and C22:6. For the mono-unsaturated fatty acids (MUFA) no set pattern was observed. However, C16:1 increased proportionally with the increase in fish oil contents of the diet. The polyunsaturated fatty acids (PUFA) were more concentrated in the meat than in the fat. A decrease in the total concentration of PUFA's was detected with the increase in the amount of fish oil in the diet, which is primarily due to the decrease in *n*-6 PUFA's which include C18:2, C18:3*n*-6 and C20:4. The *n*-3 fatty acids, C20:5 and C22:6, showed an increase with an increase in fish oil concentration. This would seem to confirm that the omega-3 family of fatty acids interferes with the synthesis of the omega-6 (C18:2*n*-6, C18:3*n*-6 and C20:4*n*-6) fatty acids (Miller *et al.*, 1969; Hulan *et al.*, 1988). The lipid content of the meat is much lower than in the fat pads and consist mostly of phospholipids, hence the higher level of PUFA. The fat pads on the other hand, would have higher levels of triglycerides and the phospolipids would thus be smaller proportion of the total lipid concentration.

Table 2. The fatty acid profile of ostrich fat and meat (% of total fatty acids).

	Fat samples				Meat samples			
	Diets				Diets			
	D1 (0%)	D2 (0.6%)	D3 (1.2%)	D4 (1.8%)	D1 (0%)	D2 (0.6%)	D3 (1.2%)	D4 (1.8%)
SFA								
10:0	0.14±0.07	0.04±0.06	0.03±0.07	0.15±0.07	1.59±0.36	1.78±0.36	0.77±0.39	1.46±0.36
12:0	0.54±0.14^{a}	0.81±0.13^{ab}	0.57±0.14^{a}	1.02±0.14^{b}	0.01±0.03^{a}	0.04±0.03^{ab}	0.08±0.03^{ab}	0.10±0.03^{b}
13:0					0.38±0.41	1.10±0.41	0.45±0.44	0.44±0.41
14:0	1.32±0.59^{a}	4.07±0.052^{b}	4.98±0.59^{b}	5.34±0.56^{b}	0.79±0.17^{a}	0.97±0.17^{a}	1.67±0.18^{b}	2.62±0.17^{c}
15:0	1.13±0.07^{a}	1.15±0.06^{a}	0.93±0.07^{b}	1.05±0.07^{ab}	0.11±0.06	0.07±0.06	0.23±0.07	0.11±0.06
16:0	32.50± 0.70	32.55± 0.63	33.47± 0.70	32.96± 0.68	21.79±0.87^{ab}	19.32±0.87^{a}	24.19±0.93^{b}	23.99±0.87^{b}
17:0	1.37±0.28^{a}	0.85±0.25^{ab}	0.90±0.28^{ab}	0.50±0.27^{b}	0.89±0.14^{a}	0.83±0.14^{a}	0.81±0.15^{a}	0.19±0.14^{b}
18:0	9.71±0.44^{a}	9.44±0.39^{a}	6.93±0.44^{b}	6.95±0.42^{b}	13.95±0.54^{ab}	15.19±0.54^{a}	13.33±0.58^{b}	13.36±0.54^{b}
22:0	0.00±0.34^{a}	0.94±0.30^{b}	2.59±0.34^{c}	3.41±0.32^{c}				
Total	46.71	49.85	50.40	51.38	39.51	39.3	41.51	42.27
MUFA								
15:1	0.59±0.05^{a}	0.38±0.04^{b}	0.34±0.05^{b}	0.43±0.05^{b}	0.10±0.06	0.03±0.06	0.17±0.06	0.12±0.06
16:1	5.39±0.40^{a}	6.33±0.35^{a}	8.67±0.40^{b}	9.07±0.38^{b}	3.65±0.35^{ab}	2.94±0.35^{a}	4.45±0.38^{b}	5.75±0.25^{c}
17:1	0.88±0.17^{a}	0.38±0.16^{b}	0.33±0.17^{b}	0.28±0.17^{b}	0.66±0.27^{ab}	1.05±0.27^{a}	0.57±0.29^{ab}	0.10±0.27^{a}
18:1	22.77±0.68^{a}	20.72±0.61^{b}	20.41±0.68^{b}	19.38±0.65^{b}	21.37±0.64	20.37±0.64	21.64±0.68	21.74±0.64
20:1	0.14±0.12^{ab}	0.42±0.10^{a}	0.09±0.12^{b}	0.29±0.11^{ab}	1.88±0.49^{a}	0.21±0.49^{b}	0.27±0.53^{b}	0.26±0.49^{b}
Total	29.77	28.23	29.84	29.45	27.66	24.6	27.1	27.97
PUFA								
18:2	10.80±0.59^{ab}	12.00±0.53^{a}	10.28±0.59^{b}	10.07±0.57^{b}	17.95±0.69^{a}	18.05±0.69^{a}	14.55±0.74^{b}	14.43±0.69^{b}
18:3(*n*-3)	9.97±0.64^{a}	8.44±0.58^{ab}	7.56±0.64^{b}	6.59±0.62^{b}	5.61±0.31^{a}	3.08±0.31^{b}	3.65±0.33^{b}	3.33±0.31^{b}
18:3(*n*-6)	0.36±0.07^{a}	0.23±0.06^{ab}	0.17±0.07^{ab}	0.16±0.07^{b}	0.61±0.14^{a}	0.09±0.14^{b}	0.02±0.15^{b}	0.00±0.14^{b}
20:4	1.95±0.542^{a}	0.37±0.48^{b}	0.23±0.54^{b}	0.56±0.52^{ab}	6.37±0.65^{a}	8.91±0.65^{b}	7.26±0.69^{ab}	5.51±0.65^{a}
20:5	0.16±0.09	0.11±0.08	0.11±0.09	0.30±0.09	1.10±0.63^{a}	3.26±0.63^{b}	5.03±0.68^{b}	3.10±0.63^{b}
22:6	0.21±0.13^{a}	0.73±0.12^{b}	1.33±0.13^{c}	1.53±0.13^{c}	1.12±0.44^{a}	2.64±0.44^{b}	2.24±0.48^{ab}	3.49±0.44^{b}
Total	23.45	21.88	19.68	19.21	32.76	36.03	32.75	29.86

a-c: Values in the same row with different superscripts differ significantly ($P<0.05$)

Conclusion

In these results it could be seen that the highest fish oil concentration in the diet, was low enough not to have a significant effect on the sensory quality of the meat with regards to flavour and aroma. However, the effect of the fish oil could be detected easily in the fat. This is therefore an indication that most of the chemical bindings that are responsible for the fishy aroma and flavour, accumulates in the fat to a greater degree than in the meat. A higher concentration of fish oil would therefore not necessarily lead to a significant difference in the meat. A fishy aroma and flavour in ostrich fat was related to increasing amounts of unrefined fish oil ingested by the birds. The fish aroma was detected at even the lowest level of fish oil ingestion levels. From the results presented above it is concluded that feeding of ostriches with feeds enriched with up to 1.8% of fish oil, would result in consumers not detecting any fishy aroma or taste in the ostrich muscle.

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