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PROCEEDINGS OF THE NUTRITION SOCIETY

ABSTRACTS OF COMMUNICATIONS

A Scientific Meeting was held at the University of Aberdeen on Wednesday and Thursday, 7/8 April 1993 when the following papers were presented.

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Response of secondary hair follicles of the Cashmere goat to prolactin in vitro. By M. IBRAHEEM[1], H. GALBRAITH[1], J. R. SCAIFE[1] and S. EWEN[2], [1]Department of Agriculture, 581 King Street, Aberdeen AB9 1UD and [2]Department of Pathology, University of Aberdeen, Medical School, Cornhill Road, Aberdeen AB9 2ZD

The pattern of hair growth in many temperate mammalian species can be manipulated by changes in photoperiod or treatment with melatonin or prolactin. The mechanisms by which melatonin and prolactin affect the hair growth cycle are largely unknown. This lack of knowledge is partly due to the absence of reliable in vitro models for the culture of hair follicles which would allow the direct investigation of hair growth. Recently we have developed a tissue culture technique for the isolation and maintenance of secondary hair follicles of the Angora and Cashmere goats (Ibraheem et al. 1992, 1993). The objective of the present study was to investigate the effect of prolactin on the growth of secondary hair follicles of the Cashmere goat.

Skin samples from the mid-rib area of five Cashmere goats were taken immediately post-mortem. Secondary hair follicles were isolated from the dermal layer of the skin as described previously (Ibraheem et al, 1993) and maintained in Williams E medium in individual wells of multi-well plates at 37°C in an atmosphere of CO_2-air (5:95, v/v).

The medium was supplemented with one of six concentrations of ovine prolactin (NIDDK-oPRL-19,NIH, Baltimore; Md, USA) (0, 50, 200, 400, 800, 4000 μg/l). Measurement on the follicles (sixty per treatment) was made using an inverted microscope fitted with an eyepiece measuring graticule. There were no differences in the viability of follicles across treatments. Increases in hair shaft length (means and pooled SEM, n 5) of follicles, which expressed growth in each 24 h measuring period and cumulatively over 120h, are shown in the Table.

	Increases in hair shaft length (mm/24h & total mm)						
Prolactin μg/l ... Time period (h)	0	50	200	400	800	4000	Pooled SEM
24	0.14	0.15	0.20	0.16	0.17	0.19	0.012
48	0.14	0.16	0.20	0.18	0.19	0.19	0.012
72	0.12	0.13	0.16	0.16	0.12	0.13	0.007
96	0.13	0.14	0.14	0.16	0.13	0.13	0.010
120	0.14	0.14	0.14	0.17	0.15	0.10	0.009
Cumulative total	0.67	0.72	0.84**	0.83**	0.76*	0.74*	0.026

Significance tested between zero prolactin and individual treatments at 120h; *P<0.05, **P<0.01.

The results indicate that the follicles which were exposed to the physiological concentrations of 200μg prolactin/l or above showed significantly higher rates of hair shaft elongation over 120h maintenance than follicles not exposed to prolactin. It is suggested that prolactin may have a direct action on the secondary hair follicles of the cashmere goat.

Ibraheem, M., Galbraith, H., Scaife, J.R. & Ewen, S. (1992). *Journal of Reproduction and Fertility Abstract Series*, **10**, 72.

Ibraheem, M., Galbraith, H., Scaife, J.R. & Ewen, S. (1993). *Journal of Anatomy* **182** (In the Press).

Factors affecting the freezing point depression of milk 2 By MOHAMMEDI, H.M., BARCLAY, M.N.I. and THOMAS, P.C., Scottish Agricultural College, Auchincruive, Ayr KA6 5HW

It is widely accepted that the average freezing point depression (FPD) of cow's milk is normally approximately -543 milli-degrees Hortvet (m°H) and a smaller depression than -530m°H usually indicates the presence of extraneous water. As we have shown (Mohammedi *et al.* 1992), differences in feeding and sampling times can significantly alter the FPD of both the milk and plasma without extraneous water being implicated.

In an experiment with four dairy goats, the FPD was measured at 1 h intervals with the goats fed at 2 h intervals, once or twice daily. The mean results are shown in the Table.

Feeding regimen	FPD (-m°H)		FPD range (-m°H)		Water Intake (l)
	Mean	*SD*	Max	Min	
2 h intervals	582	5.05	573	592	2.09
Twice daily	572	8.18	556	590	3.03
Once daily	575	7.92	562	587	2.22
Once daily, water controlled	577	11.60	554	590	N/A

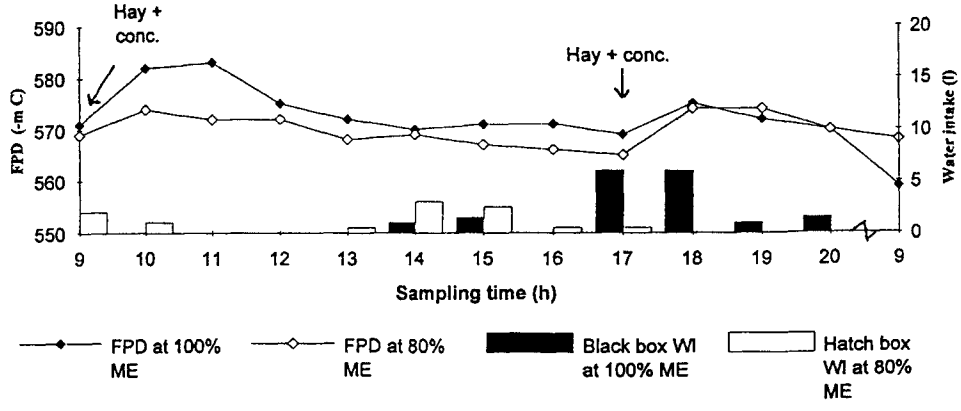
N/A, Not Applicable

When water was not available until 5 h after feeding (water controlled) the FPD reached extremes for individual animals of maximum -547m°H and minimum -596m°H.

When different levels of feeding were examined (Fig. 1), the food - water intake interaction was again observed. Analysis of variance in the factors concerned (water intake, level of feeding and timing of feeding = treatment, individual animal variation = animal) showed a relationship, FPD = -586m°H + 1.37 (water/l) + 1.65 (treatment) + 1.09 (animal) ($P < 0.001$).

Further experimental work is needed to refine this equation but it means that considerable variation in FPD can be obtained under 'normal' conditions of animal management.

Fig. 1 Effect of different levels of feeding on FDP



Mohammedi, H., Thomas, P.C. & Barclay, M.N.I. (1992). Proceedings of the Nutrition Society **51**, 141 A.

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Blood acid-base and urinary excretion during chronic ingestion of a drink with acute alkalizing properties. By J.B. LEIPER and R.J. MAUGHAN, Department of Environmental and Occupational Medicine, University Medical School, Foresterhill, Aberdeen AB9 2ZD

Dietary modification can induce changes in blood and urine acid-base status which may alter the urinary excretion of calcium (Ca) and magnesium (Mg). We have previously shown that a commercial fruit-based soft drink can produce an acute alkaline shift in fasted subjects (McBrine et al. 1990). We have investigated the effect on acid-base status and urinary excretion of Ca and Mg of chronic ingestion of this drink.

Twenty healthy volunteers (9 females and 11 males; age range 18 to 42 years) ingested this drink (500 ml) each evening for 28 consecutive days. During this period subjects ate their normal diet and continued their normal life-style, but refrained from alcohol and unaccustomed exercise for the 24 h preceding blood and urine collection. After an overnight fast an arterialized-venous blood sample was obtained from a dorsal vein of the heated hand: samples were collected on the 2 consecutive days before drinking (Pre), on days 14, 15, 28 and 29 after starting to drink, and on days 6 and 7 after finishing drinking (Post). Urine collections (24 h) were made over the period immediately preceding blood collections. Plasma pH and blood carbon dioxide tension were measured using a blood gas analyzer; plasma bicarbonate and blood base excess (BE) were calculated; 24 h urinary excretion of acid was determined titrimetrically, and Ca and Mg excretion was determined by ion chromatography.

There was no change in blood acid-base status as a result of ingestion of the soft drink. There was a tendency for decreased urinary excretion of acid ($P = 0.67$), Ca ($P = 0.23$) and Mg ($P = 0.14$) during the treatment period, although this never reach statistical significance (see table).

Day of sample...	Pre		14 - 15		28 - 29		Post	
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Plasma pH	7.41	0.03	7.41	0.02	7.41	0.03	7.41	0.02
Blood BE (mmol/l)	-2.4	1.6	-2.3	1.6	-2.0	1.9	-2.0	1.9
Urinary acid (mmol/d)	62	29	53	26	54	24	60	23
Calcium (mmol/d)	4.7	3.0	3.7	2.5	3.7	1.9	5.0	2.9
Magnesium (mmol/d)	3.6	1.7	2.7	1.5	3.0	1.3	3.6	1.4

* values are the mean of two consecutive days with their standard deviation

These data suggest that, although ingestion of this drink can produce an acute alkaline shift, this effect cannot be detected chronically in individuals consuming a mixed diet. During daily ingestion of the drink there appeared to be a tendency for decreased urinary excretion of Ca and Mg which did not reach statistical significance. The lack of a conclusive response may be due to the relatively large daily variation in composition of the diet masking the effect or to homeostatic mechanisms maintaining the blood variables without markedly altering the urinary output.

McBrine, J., Leiper, J.B. & Maughan, R.J. (1989). Proceedings of the Nutrition Society **48**, 171A

The effect of consuming the sodium salts of two weak organic acids for 5 consecutive days on acid-base status in man. By D. BALL and R.J. MAUGHAN, Department of Environmental and Occupational Medicine, University Medical School, Aberdeen, AB9 2ZD.

The ingestion of sodium citrate has an alkalinizing effect on urine that is apparent after 24 h and is sustained for several days if ingestion of the salt is continued (Sakahee et al. 1983). Over a 3 h period the ingestion of sodium citrate has an alkalinizing effect on blood (McNaughton. 1990). Whether this alkalinising effect on blood is sustained over a longer period is not known. Six healthy males volunteered for the present experiment, which had local Ethics Committee approval. On two separate occasions 7 d apart, subjects consumed either tri-sodium citrate-sodium tartrate (1:0.9, w/w; treatment, T) or cornflour (placebo, P), at a dosage of 0.15g/kg body weight for 5 consecutive days. Treatment conditions were assigned in randomised order. During each trial eight consecutive 24 h urine were completed by each subject, commencing the day before T and P ingestion. Urine samples were analysed for pH, titratable acid (Jorgensen. 1957) and electrolyte concentration. Following an overnight fast arterialized-venous blood samples were taken on the first, second and fifth days of either T or P ingestion. Blood samples were analysed for acid-base status. Statistical analysis was by repeated measures two-way ANOVA and by post-hoc Tukey test where a difference was found. Urine acid-base status before, during and after 5 d of ingesting either T or P is shown in the table. Significant differences ($p<0.05$) between T and P are denoted by *.

Time of collection	pH				Titratable acid (mEq/24h)			
	T		P		T		P	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pre-ingestion	6.32	0.32	6.25	0.54	54.6	35.6	61.6	44.0
Day 1	7.05	0.17 *	6.00	0.46	-10.4	16.7 *	72.8	40.0
Day 2	7.17	0.18 *	6.07	0.19	- 7.6	16.6 *	66.1	35.7
Day 3	6.90	0.34 *	5.83	0.29	16.5	25.3 *	85.0	40.2
Day 4	7.16	0.50 *	5.90	0.38	5.7	38.5 *	77.7	36.1
Day 5	6.89	0.24	5.90	0.21	25.3	45.8 *	75.8	27.2
Day 1 Post-ingestion	5.99	0.30	6.09	0.35	67.7	22.3	82.1	32.1
Day 2 Post-ingestion	6.37	0.38	6.15	0.58	49.1	34.5	71.3	40.0

Blood acid-base status was not different before T and P ingestion. Although previous data from our laboratory and others have shown an alkalinising effect over a 3-h period following the ingestion of these sodium salts, there was no effect on arterialized-venous blood samples after an overnight fast on days 2 and 5. There was an alkalinizing effect on urine during the days of T consumption and a tendency for the urinary excretion of Na to increase. These data suggest that renal compensation allows blood acid-base status to be maintained within normal limits despite a sustained alkali load.

Jorgensen, K. (1957) Scandinavian Journal of Clinical and Laboratory Investigation **9**, 287-291.

McNaughton, L. (1990). European Journal of Applied Physiology **61**, 392-397.

Sakahee, K., Nicar, M., Hill, K. & Pak, C.Y.C. (1983). Kidney International **24**, 348-352.

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The effect of dietary lipid manipulation on food intake, weight gain and tissue weights of rats. By P. YAQOOB, E. J. SHERRINGTON, E. A. NEWSHOLME and P. C. CALDER, Department of Biochemistry, University of Oxford, South Parks Road, Oxford OX1 3QU

Epidemiological studies indicate that populations which consume large amounts of fish oil have a lowered incidence of cardiovascular, inflammatory and autoimmune diseases and some cancers. In addition, the *n*-3 polyunsaturated fatty acids (PUFA) contained in fish oils are believed to play a role in growth and development. As a result of these observations, increased fish oil consumption has been proposed for the prevention and therapy of a number of widespread diseases and for the attainment of general good health. Dietary vegetable oils such as evening primrose oil and olive oil have also been claimed to be beneficial to health. However, few studies have made systematic comparisons between a number of different dietary lipids. In the present study the effects of a variety of dietary lipids on animal growth and tissue size were investigated.

Weanling Lewis rats (73.4 (SEM 1.6) g; *n* 30) were fed for 10 weeks on a low (20 g/kg) fat diet (LF) or on diets containing 200 g/kg hydrogenated coconut oil (HCO; rich in saturated fatty acids), olive oil (OO; rich in the *n*-9 monounsaturated fatty acid oleic acid), safflower oil (SO; rich in *n*-6 PUFAs), evening primrose oil (EPO; containing the *n*-6 PUFA γ-linolenic acid) or menhaden oil (MO). All diets contained a further 10 g corn oil/kg to prevent essential fatty acid deficiency, 1.2 g vitamin E/kg as antioxidant and adequate amounts of vitamins, minerals and fibre. Food intake, weight gain and tissue weights (all *n* 5) at sacrifice were measured.

			Tissue weight (g)													
	Weight gain (g)		Liver		Brain		Heart		Spleen		Thymus		CLN		MLN	
Diet	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM
LF	252.7	4.2	12.9	0.3	1.94	0.08	1.21	0.03	0.61	0.02	0.63	0.05	0.18	0.01	0.20	0.01
HCO	315.6*	13.2	14.9*	0.5	1.80	0.10	1.25	0.04	0.63	0.02	0.68	0.05	0.14*	0.01	0.13*	0.01
OO	286.6*	9.8	14.2*	0.3	1.78	0.09	1.32	0.08	0.54*	0.02	0.75	0.04	0.15	0.02	0.09*	0.01
SO	321.6*	6.7	13.7	0.2	1.85	0.09	1.31	0.04	0.64	0.04	0.82	0.09	0.13*	0.01	0.13*	0.01
EPO	301.8*	6.9	14.3*	0.4	1.82	0.05	1.30	0.05	0.63	0.02	0.79	0.08	0.15	0.03	0.11*	0.01
MO	326.6*	4.7	18.1*	0.3	1.78	0.10	1.34*	0.02	0.74*	0.02	0.93*	0.12	0.13*	0.01	0.15	0.02

* significantly different ($P<0.05$) from LF (Student's *t*-test)
CLN indicates cervical lymph nodes; MLN indicates mesenteric lymph nodes

Food intake of the LF-fed animals (1.55 (SEM 0.03) kg; *n* 5) was significantly greater than that of the animals fed on the high fat diets (1.18 (SEM 0.01) kg; *n* 25). Total energy intake was the same for animals fed on the LF diet (5425 (SEM 105) Cal; *n* 5) and for those fed on the high fat diets (5390 (SEM 85) Cal; *n* 25). The LF-fed animals had a lower weight gain, and smaller final weights, than animals fed on the other diets. Animals fed on the MO diet had a greater weight gain than those fed on the OO or EPO diets and their final weights were greater. The MO diet resulted in increased liver size, compared with each of the other diets, whether the size is expressed as absolute weight or as percentage of body weight (%bw). Absolute brain weight was unaffected by dietary lipid manipulation, but as %bw the brains from animals fed on the HCO, SO, EPO or MO diets were smaller than those from animals fed on the LF diet. Absolute heart size was increased by the MO diet, compared with the LF diet, but heart size as %bw was reduced by the HCO, SO, EPO and MO diets. Compared with the LF, HCO, OO or EPO diets, spleen size was increased by the MO diet, while the HCO, OO, SO and EPO diets resulted in smaller spleens as %bw than the LF diet. Thymus size expressed as %bw was unaffected by the high fat diets, although the absolute weights of thymi from MO-fed animals were greater than those from animals fed on the LF diet. Expressed as either absolute weight or %bw, CLN size was reduced by the HCO, SO and MO diets while MLN size was reduced by feeding each of the high fat diets. Although significant, these changes in tissue weight do not account for the differences in body weight between animals fed on different diets. It is likely that much of the difference in body weight is due to variations in adipose tissue deposition between the diets.

The effect of dietary lipid manipulation on serum lipid concentrations and fatty acid composition. By P. YAQOOB, E. J. SHERRINGTON, D. J. HARVEY, E. A. NEWSHOLME and P. C. CALDER, Department of Biochemistry, University of Oxford, South Parks Road, Oxford OX1 3QU

Saturated fat consumption is associated with the development of cardiovascular disease, an effect at least partially due to the elevated blood cholesterol and triacylglycerol levels caused by such diets. Consumption of fish oils (rich in *n*-3 polyunsaturated fatty acids (PUFA)) or vegetable oils, such as olive oil (rich in the *n*-9 monounsaturated fatty acid oleic acid) or safflower oil (rich in *n*-6 PUFA), has been recommended for both the prevention and the therapy of these diseases. The beneficial effects of the unsaturated fatty acids contained in vegetable and fish oils appear to be due to a combination of effects including the lowering of blood cholesterol and triacylglycerol levels and the modulation of platelet, immune cell and smooth muscle cell functions. These effects probably require that the dietary lipid manipulation alters both blood lipid levels and fatty acid composition. In the present study the effects of a variety of dietary lipids were compared.

Weanling Lewis rats were fed for 10 weeks on a low (20 g/kg) fat diet (LF) or on diets containing 200 g/kg hydrogenated coconut oil (HCO; rich in saturated fatty acids), olive oil (OO), safflower oil (SO), evening primrose oil (EPO; containing the *n*-6 PUFA γ-linolenic acid) or menhaden oil (MO). All diets contained a further 10 g corn oil/kg to prevent essential fatty acid deficiency, 1.2 g vitamin E/kg as antioxidant and adequate amounts of vitamins, minerals and fibre. Serum total cholesterol (CHOL), cholesterol ester (CE) and triacylglycerol-glycerol (TAG) concentrations (all in mg/ml) were measured using standard enzymic assays. Serum lipid was extracted and saponified and the fatty acid composition was determined by gas chromatography of the fatty acid methyl esters.

	CHOL		CE		TAG		Fatty acid (mol %)									
Diet	Mean	SEM	Mean	SEM	Mean	SEM	12:0	14:0	16:0	16:1 *n*-7	18:0	18:1 *n*-9	18:2 *n*-6	18:3 *n*-6	C20¶	C22¶
LF	0.95	0.06	0.76	0.09	0.08	0.01	nd	0.88	25.81	2.01	16.95	11.56	21.25	nd	15.71	5.01
HCO	1.15	0.08	0.87	0.14	0.22*	0.03	4.65	4.38	20.46	1.94	25.12	11.01	11.19	nd	15.69	2.75
OO	1.53*	0.19	1.14	0.34	0.24*	0.05	nd	0.42	16.42	0.83	21.04	23.65	12.54	nd	18.12	3.87
SO	1.19*	0.05	0.92	0.07	0.08	0.02	nd	0.53	17.94	0.36	20.67	5.63	28.93	nd	19.88	4.43
EPO	1.32*	0.06	0.99	0.10	0.07	0.01	nd	0.37	18.17	0.42	19.31	5.42	27.26	1.23	21.35	4.73
MO	0.71*	0.05	0.54*	0.03	0.08	0.02	nd	1.79	25.32	4.92	15.75	10.28	7.51	nd	17.91	13.51

* significantly different ($P<0.05$) from LF (Student's *t*-test); n 5; nd indicates not detected
SEM values for the fatty acid composition data were less than 10% of the mean in all cases; n 5
¶Total of all 20 and 22 carbon fatty acids, respectively

Serum total cholesterol levels were higher after feeding the OO, SO or EPO diets than after the LF or MO diets. Surprisingly, the HCO diet did not raise the cholesterol concentration above that of the LF diet. Despite containing 200 g fat/kg, the MO diet resulted in a serum cholesterol concentration lower than that of animals fed on the LF diet. The serum cholesterol ester concentration of the MO-fed rats was significantly lower than those fed on the LF, HCO, SO or EPO diets. Serum triacylglycerol concentrations of the HCO- and OO-fed animals were significantly higher than those of the LF-, SO-, EPO- and MO-fed animals. These data show that a fish oil diet prevents the elevation in blood cholesterol and triacylglycerol concentrations caused by some other high fat diets, and that the resulting concentrations can be as low as, or lower than, those of animals on a low fat diet. The serum fatty acid composition showed significant differences between the diets, the composition reflecting that of the diets themselves.

Fish-oil supplementation changes membrane fluidity and phospholipid profiles in humans. By E. K. LUND, C. A. FARLEIGH, S. LADHA, L. J. HARVEY and I. T. JOHNSON, AFRC Institute of Food Research Norwich Laboratory, Norwich Research Park, Colney, Norwich NR4 7UG

Supplementation of the diet with *n*-3 polyunsaturated fatty acids (PUFA) alters the fatty acid profile of cell membrane phospholipids from a number of different tissues. An increase in the percentage of long-chain PUFA in liposomes has been shown to increase membrane fluidity as measured using the fluorescence polarization technique (Brasitus et al. 1985). In the present study we have compared the degree to which human cheek and erythrocyte membrane lipids can be altered by supplementation with *n*-3 PUFA. We have also assessed the extent to which dietary manipulation of phospholipids can affect membrane fluidity, using a technique that specifically measures fluidity of the plasma membrane.

To assess normal dietary fatty acid profiles duplicate diets were collected from seventeen volunteers (eight female, nine male) aged 20-56 years, over a period of 7 d, prior to the start of dietary supplementation. Fish oil (3g/d; 930 mg EPA, 630 mg DHA), as capsules (EPA Forte, Booker Health Products,Surrey), was given to each subject for 42 d. Blood and cheek cell samples were collected at the start of the experiment, after 21 and 42 d and after a further 42 d without supplementation. Membrane fluidity was measured in washed erythrocytes, at 37°, using the fluorescence recovery after photobleaching technique (FRAP; Clark et al. 1990). Lipids were extracted from diets and cells with chloroform-methanol (2:1, v/v). Part of the lipid extract from the cells was used to isolate phospholipids by TLC. After hydrolysis and methylation (BF_3: methanol), the proportions of individual fatty acids in the phospholipid fraction of the cell, and in the total dietary lipid extract, were measured by GLC. Free cholesterol in the lipid extracts was measured enzymically.

The *n*-3 PUFA supplementation caused an initial increase the proportion of *n*-3 fatty acids in the cheek cell membrane phospholipids, followed by a decrease in *n*-6 fatty acids. Corresponding changes in erythrocyte levels were also detected. It was not possible to measure fluidity in cheek cells, due to the structural characteristics of the cell membrane. In the case of erythrocytes, the initial fluidity of the plasma membrane was significantly correlated with the amount of C20:5, eicosapentanoic acid, in the phospholipid extract (r 0.546; $P<0.05$). Feeding fish oil increased the fluidity of the cell membrane, measured as the coefficient of diffusion of the fluorescent probe. This variable increased significantly from 7.2 (SE 0.7) cm^2/s at the start to 9.8 (SE 0.5) cm^2/s after 21 d ($P<0.05$). After 42 d the cell membrane coefficient of diffusion was 8.2 (SE 0.8) cm^2/s, but even 42 d after the end of supplementation the fluidity was 8.8 (SE 0.5) cm^2/s, which was significantly greater than at the start $P<0.05$. These results indicate that consumption of moderate quantities of fish oil cause a detectable change in the physical properties of cell membranes, however the relationship between the fatty acid profile of the membrane and the fluidity is complex.

This work was supported by The Ministry of Agriculture, Fisheries and Food.

Clark, D.C., Coke, M., Mackie, A.R., Pinder, A.C. & Wilson, D.R. (1990). Journal of Colloid and Interface Science **138**, 207-219.

Brasitus, T.A., Davidson, N.O. & Schachter, D. (1985). Biochemica et Biophysica Acta **812**, 460-472.

Fish consumption in North Glasgow: results from the MONICA studies of 1986 and 1989. By W. L. WRIEDEN[1], C. BOLTON-SMITH[2], C.A.BROWN[2] and H.TUNSTALL-PEDOE[2], [1]School of Food and Accommodation Management, Duncan of Jordanstone College of Art, University of Dundee, Dundee, DD1 4HT, [2]Cardiovascular Epidemiology Unit, Ninewells Hospital and Medical School, Dundee, DD1 9SY

A food frequency questionnaire (Bolton-Smith et al 1991) was used to assess fish consumption in random samples of men and women in North Glasgow in 1986 and 1989. Subjects were asked how often they ate white fish (which included fried white fish and fish fingers) and oily fish (including tuna and salmon). To allow for a change in socio-economic profile of the sample populations, results are given separately for owner occupiers (OO) and local authority renters (LAR). Cross-tabulations with chi-square analysis were used to examine any changes in consumption from 1986 to 1989 and any differences in consumption between the OO and LAR groups. In all groups approximately one half reported that they ate white fish once per week and a quarter stated they ate white fish two or more times per week, making the estimated percentage of white fish eaters to be about 75%. However, among women of the OO group in 1989 there was a lower percentage (8.2%) who rarely or never ate white fish than among women of the LAR group (17.3%) in the same year ($P<0.01$).

The Table shows the percentage of OO and LAR who eat oily fish rarely or never (R or N), less than once per week (<1pw), once per week (1pw) or two or more times per week (2+pw).

	Men				Women			
	1986		1989		1986		1989	
	OO	LAR	OO	LAR	OO	LAR	OO	LAR
R or N	40.0	45.8	39.1	42.6	29.4	44.2	29.6	45.0
<1pw	28.9	22.9	30.0	22.7	33.3	23.6	26.6	17.6
1pw	23.7	20.5	22.7	24.4	26.7	24.7	21.3	24.6
2+pw	7.4	10.8	8.2	10.3	10.6	7.5	22.5	12.8
						++	**	*+++
n	190	371	233	291	180	373	267	391

Significantly different from OO in same year: ++P<0.01, +++P<0.001
Significantly different from the same group in 1986: *P<0.05, **P<0.01

There was a shift in oily fish consumption in women from 1986 to 1989 with a higher percentage in 1989 reporting that they ate such fish two or more times a week. However the percentage of rare and non-consumers remained the same. It was also evident, in women only, that owner occupiers were more likely to eat oily fish than the local authority renters. These trends were insignificant in men.

These results suggest that women, particularly those in the higher socio-economic groups, are more likely to respond to messages that oily fish may help to prevent heart disease (Kromhout, 1990) than men. However, examination of mean blood pressure and blood cholesterol levels in the different oily fish consumption groups showed no significant trend in these risk factors with increasing fish consumption in any of the standardized groups.

Bolton-Smith, C., Smith, W.C.S., Woodward, M. & Tunstall-Pedoe,H. (1991). British Journal of Nutrition **65**, 321-335.
Kromhout, D.H. (1990). BNF Nutrition Bulletin **59**, 93-102.

Contribution of selenium content of fish on dietary intake By M.N.I. BARCLAY and A. MacPHERSON, Scottish Agricultural College, Auchincruive, Ayr KA6 5HW

Bread flour has traditionally been the best source of dietary Se until the recent increase in the use of home-grown wheat has resulted in the inclusion of only 13.8 % wheat from Canada. We have monitored the Se content of breadmaking wheat (Barclay & MacPherson, 1986, 1992) and shown its diminishing contribution to dietary supply.

Fish, particularly oily fish, has been shown to be another rich source of Se (Thorn et al., 1978). In order to examine the current position, samples were obtained weekly through Ayr and Aberdeen fish markets during July and August 1992.

Fish Type (Source)	n	Se content (μg/g) Dry wt Mean	*SE*	Fresh wt Mean	*SE*
Herring (North Sea)	5	1.162	0.16	0.410	0.04
Herring (Clyde)	6	1.087	0.10	0.344	0.01
Mackerel (North Sea)	5	1.55	0.30	0.505	0.05
Mackerel (Clyde)	3	1.40	1.17	0.444	0.02
Trout (farmed)	8	0.808	0.04	0.222	0.01
Salmon (farmed)	1	0.89	nd	0.262	nd
White fish (mixed)	6	1.615	0.152	0.323	0.026
White fish (cod)		nd	nd	nd	nd

nd, not determined.

The white fish content appears to have risen since 1978 levels when there was only one sample analysed. These results are in agreement with those of Vlieg (1990) who has shown that for New Zealand fish species the Se content of fish flesh is very much higher than for animal meat products.

From the given data and using the MAFF (1991) Annual Report for the National Food Survey Committee Household Food Consumption and Expenditure HMSO 19% of dietary Se now comes from fish. However, this indicates an average fish intake of 125g/week for UK and 115g/week for Scotland, against an intake of 875 and 850 g respectively for total meat. These are average figures and our limited dietary information from the Ayrshire Heart Health Study would suggest that the majority of people do not eat as much fish as this. This would suggest a significantly reduced Se intake for these people.

Barclay, M.N.I., MacPherson, A., Taylor, C. & Auld, W.H.R. (1986). Journal of the Science of Food and Agriculture **37**, 1133-1138.

Barclay, M.N.I. & MacPherson, A. (1992). British Journal of Nutrition **68**, 261-270.

Thorn, J., Robertson, J., Buss, D.H. & Bunton, N.G. (1978). British Journal of Nutrition **39**, 391-396.

Vlieg, P. (1990). Journal of Food Composition and Analysis **3**, 67-72.

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