Nutrición Hospitalaria

Nutr Hosp. 2011;26(4):907-915
ISSN 0212-1611 • CODEN NUHOEQ
S.V.R. 318

Original

The effect of a modified meat product on nutritional status in institutionalized elderly people

M.ª J. Beriain[1], F. C. Ibáñez[1], J. Baleztena[2] and E. Oria[3]

[1]School of Health Sciences. Division of Nutrition and Food Science. Public University of Navarre. Pamplona. Spain. [2]Grupo AMMA Nursing Home. Pamplona. Spain. [3]Department of Dietetic and Nutrition. Hospital of Navarre. Pamplona. Spain.

Abstract

Objective: **To determine whether the inclusion of a new modified meat product as a dietary supplement has a positive influence on the nutritional status and blood lipid profile of institutionalized elderly subjects.**

Method: **A sample population of elderly people living in institutions (9 men and 29 women aged 68-97 years) completed a crossover study with two dietary supplements. Nutritionally complete diets differed only in food supplementation, first, with a standard meat product and, subsequently, with a modified meat product. Venous blood samples were taken prior to each of the three phases of the study: the basal phase, during which participants followed their normal, controlled diet; a control phase (3 days per week for 3 weeks), during which the subjects' normal diet was supplemented with 50 g of the standard product; and an experimental phase (3 days per week for 3 weeks), when the normal diet was supplemented with 50 g of the modified product.**

Results: **Nutritional intervention did not influence hematological parameters or serum lipids. The modified meat product altered blood concentrations of urea, creatinine, GOT, transferrin, iron, and retinol-binding protein.**

Conclusions: **Consumption of both the standard and the modified products contributes to maintaining the individuals' nutritional status and equalizes nutritional status across the study population with no effect on blood lipid profiles. Despite the limitations of the experiment, the introduction of dietary supplements in meat products significantly increased plasma iron levels in this elderly sample.**

(*Nutr Hosp.* 2011;26:907-915)

DOI:10.3305/nh.2011.26.4.5142

Key words: *Meat emulsion. Oleic acid. Lipoprotein. Nutritional status. Elderly people.*

EFECTO DE UN PRODUCTO CÁRNICO MODIFICADO SOBRE EL ESTADO NUTRICIONAL DE ANCIANOS INSTITUCIONALIZADOS

Resumen

Objetivo: **Determinar si la suplementación de la dieta normal con un producto cárnico modificado tiene un efecto positivo sobre el estado nutricional y el perfil lipídico sanguíneo de ancianos institucionalizados.**

Método: **Se aplicó un diseño cruzado a una muestra poblacional de ancianos institucionalizados (9 hombres and 29 mujeres de 68-97 años) administrando dos suplementos dietéticos. Las dietas primero se suplementaron con un producto cárnico estándar y luego con un producto cárnico modificado. Previamente a cada una de las tres fases del estudio se extrajeron muestras de sangre: fase basal, en la que los participantes siguieron su dieta habitual; fase control (3 días a la semana durante 3 semanas), en la que se suplementó la dieta con 50 g de un producto cárnico estándar y una fase experimental (3 días a la semana durante 3 semanas), en la que se suplemento la dieta con 50 g de un producto cárnico modificado.**

Resultados: **La intervención nutricional no influyó negativamente ni en los parámetros hematológicos ni en los lípidos séricos. No obstante, el consumo del producto cárnico modificado alteró las concentraciones sanguíneas de urea, creatinina, GOT, transferrina, hierro y proteína transportadora de retinol.**

Conclusiones: **El consume de ambos productos cárnicos contribuyó a mantener el estado nutricional de los sujetos homogeneizándolo en el conjunto de los mismos sin afectar negativamente al perfil lipídico sanguíneo. No obstante las limitaciones del presente estudio, se concluye que la incorporación regular de estos suplementos cárnicos mejora los niveles de hierro plasmático de los ancianos.**

(*Nutr Hosp.* 2011;26:907-915)

DOI:10.3305/nh.2011.26.4.5142

Palabras clave: *Emulsión cárnica. Ácido oleico. Lipoproteina. Estado nutricional. Anciano.*

Correspondence: María José Beriain Apesteguia.
E-mail: mjberiain@unavarra.es

Recibido: 18-XI-2010.
Aceptado: 28-XI-2010.

Introduction

Elderly people residing in institutions have been shown to have low energy and micronutrient intake.[1-3] As a result, the prevalence of malnutrition in this population ranges from 19.0-38.6%.[4] General frailty, malnutrition and multiple micronutrient deficiencies are associated with decreased functioning. Protein and micronutrient supplements may have a positive effect on nutritional status and physical and mental functioning, thereby increasing quality of life and reducing care dependence in elderly people.

Earlier studies have demonstrated the improvement of nutritional status (body weight and/or biochemical parameters) through nutritional intervention in both the institutionalized[1-3,5] and non-institutionalized elderly.[6,7] However, the administration of some dietary supplements has a limited effect on functional status in this elderly population, possibly due to their previous status.[5,8-11]

During the past decade, a wealth of evidence has been gathered linking postprandial triacylglycerol (TAG) and TAG-rich lipoprotein (TRL) metabolism with early atherosclerosis and cardiovascular disease (CVD).[12] This evidence suggests a relationship between dietary fatty acids, lipemia and CVD risk factors,[13] particularly in terms of how fatty acid intake affects the postprandial lipid profile.[14,15] However, limited evidence is available regarding the long-term effect of the quality of dietary fats on postprandial TAG and TRL metabolism.[16-18] Recent data suggest, furthermore, that the quality of dietary fat might influence insulin sensitivity.[19] Thus, some authors have conducted studies aimed at increasing omega-3 fatty acid intake from fish oils, vegetable oils[20-23] and also oleic acid. Although consumers tend to prefer lean meat, higher fat content has been associated with desirable sensory properties.[24,25] Oleic and linoleic acids increase HDL and reduce LDL blood concentrations.[26,27] More specifically, it is accepted that the intake of oils rich in oleic acid reduces total cholesterol and LDL-cholesterol concentrations, while maintaining and even raising HDL-cholesterol concentrations.[28-30] Other authors report that the consumption of a meal enriched in fish oil fatty acids improves postpandrial vascular reactivity in younger men, with little noticeable benefit in older men.[31]

Evidence associating the so-called *Mediterranean diet* with low risk of cardiovascular disease[32,33] has led to the development of a dietary model whose basic aim is to reduce total fat (TF) intake and limit that of saturated fatty acids (SFA).[34] This model was outlined in a consensus document published by the *Comité Español Interdisciplinario para la Prevención Cardiovascular*[35] which recommended < 30% of dietary energy from TF and < 33% of TF from SFA.

In the past century, the relationship between CVD risk and meat intake has been attributed to the cholesterol and fat content of meat.[36] Much of the published research was based on epidemiologic surveys.[37,38] One consequence of reducing meat intake is a decrease in body protein reserves, especially in elderly people. Another is that, since the dietary intake of iron is not sufficient to maintain iron status, iron deficiency anemia ensues.[39]

Nutritional disorders are very frequent in elderly people and involve a high morbidity and mortality risk.[40,41] Clinical, functional, dietary, and anthropometric parameters hold potential as tools for geriatric nutritional assessment.[42]

The aim of present study was to detect possible nutritional benefits in the blood lipid profile and the nutritional status of elderly people of both sexes, from the intake of a modified meat product made from turkey, and including soy fiber and olive oil as ingredients.

Material and methods

Subjects

The study was conducted in Navarra, in Northern Spain. A total of 80 subjects of both sexes, between the ages of 65 and 95 y, recruited voluntarily from two homes for the elderly and one convent, participated in the study.

Eligibility criteria were: at least two months' residence in the home; controlled diet and physical activity; MNA[43] score > 12 and no evidence of any severe disease or serious morbidity. Of the 80 subjects, 42 left the study due to loss of motivation or the frequency of the trials. In all, 38 subjects (9 men and 29 women) completed the trial. Their weight had remained stable in the 6 months prior to the study and their dietary habits showed no differences with respect to those of the local population. Informed written consent was obtained from all subjects and the protocol was approved by the Hospital Ethics Committee.

Anthropometric measurements

All subjects were weighed on the same chair scale barefoot and wearing light clothing. Height was measured with a portable stadiometer (Seca 214, Hans E. Rüth S.A. Barcelona, Spain). Body Mass Index (BMI) was calculated for all those with height and weight measurements. The anthropometric measurements (triceps skinfold thickness, mid-arm muscle circumference, leg circumference and waist circumference) were carried out according to standard techniques.[44]

Study design

This was a randomized, controlled, three-phase trial. During the first phase, designed to collect the baseline

data, participants followed their normal, controlled diet. In the second and third phases (three days per week, for three weeks), the subjects were served 50 g of the standard or the new product with their afternoon snack. To avoid tiring the subjects, no washout period was included. The null hypothesis would be accepted if no significant variation was observed in the baseline values of the subjects' nutritional status after consumption of the standard product.

At the beginning of the study, case histories of participants were taken, anthropometric data were collected, three-phase blood tests were performed to check the subjects' eligibility for the study, and initial reference data were obtained.

Analysis of meat products and dietary assessment

The standard meat product used in the study, which was manufactured with pork, bacon, starch, water and salt, was supplied by a local factory. The newly-developed meat product was prepared at the Public University of Navarra, using turkey meat, soya, olive oil, water, and common salt. Chemical analysis of both meat products was performed as described previously.[45]

Total cholesterol content was determined by gas chromatography according to the procedure described by Petrón et al.[46]

Sodium, calcium and iron were determined by atomic absorption spectrometry after dry ashing.[47]

The compositional analysis data for these products were used to determine the nutrient and energy contribution of the 3 intakes per week administered during the study. Food intake data were analyzed from the menu listings using a software package (Alimentacion y Salud, ver. 2.0, distributed by General Asde, S.A. Valencia, Spain), which is based on a Spanish food composition database.

Blood sampling and biochemical determinations

Fasting blood samples were collected in EDTA-containing (1 g/L) tubes. Plasma was separated by low-speed centrifugation at 1,500 x g at 4º C for 30 min. within 1 h of sampling.

The hemogram and leukocyte formulae were obtained using the Coulter MAXM hematology flow cytometer (Beckman Coulter, Inc, Fullerton, USA). Plasma cholesterol and triacylglycerols were determined in both plasma samples with a Vitros Chemistry Analyzer 250 (by Ortho-Clinical Diagnostics, Buckinghamshire UK) using standard enzymatic procedures[48,49] according to the manufacturer's instructions. Apo A-I, Apo B and lipoprotein α, were determined by the nephelometric method and the inter-assay variation coefficients were 5%. Using the same technique, prealbumin (calibration performed with the reference standard IFCC/BCR/CAP-CRM 470) and retinol-binding protein were determined. Albumin determination was performed using a Vitros Chemistry Analyzer 250 (by Ortho-Clinical Diagnostics, Buckinghamshire UK).

The following biochemical parameters were also determined: basal glucose, creatinine, uric acid, GOT-glutamic oxalacetic (ASAT), GPT-glutamic piruvic (ALAT), -glutamil transferase (GGT), urea, iron, and transferrin using the Vitros Chemistry Analyzer 250 (by Ortho-Clinical Diagnostics, Buckinghamshire UK).

Statistical analysis

Results are expressed as mean ± SD of replicated determinations, if normally distributed. Data were subjected to one-way analysis of variance (ANOVA) to test for significant differences between the three dietary phases. Multiple comparisons were performed with Dunnett's *post hoc* test (the control group was the diet supplemented with the standard product). Statistical significance was set at $p < 0.05$.

All statistical analyses were carried out using SPSS for Windows, ver. 17.0 (SPSS Inc., Chicago, Illinois, USA).

Results

Meat products and diets

Table I shows the chemical and fatty-acid composition of the standard and modified products, respectively. Both products have the similar moisture and protein contents, showing the two types of meat (standard and experimental) to be invariant in these respects. The modified meat product has a similar cholesterol content to that of the standard product. The formulation of the two products resulted in higher carbohydrate content (2.3% *vs* 1.2%), and lower dietary fiber content in the standard product. The iron content of both products was similar to other meat products.

The fatty-acid profiles of the two products differ in all the classes of fatty acid considered. The modified product had a high MUFA content (27.1 g/100 g) and a proportionally low SFA content, particularly with respect to atherogenic fatty acids (lauric, miristic and palmitic acids). The modified product presented a higher oleic acid content than the standard product (55.1% *vs* 38.7%), leading to significant differences in total MUFA content between the two products ($p < 0.05$). However, the higher linoleic acid content of the standard product (17.0% *vs* 13.1%) determined its higher polyunsaturated fatty acid content. The PUFA/SFA ratio was similar in both products; however, the MUFA/SFA ratio of the modified product

Table I
Chemical composition of the two products, standard and modified products, referred to 100 g of fresh product (mean ± standard deviation)

Nutrient	*standard product*	*modified product*
Moisture (g)	75.90 ± 0.28	75.90 ± 0.25
Total protein (g)	13.90 ± 0.36	13.30 ± 0.34
Total carbohydrates (g)	2.30 ± 0.05	1.20 ± 0.05
Insoluble carbohydrates (g)	0.03 ± 0.01	0.30 ± 0.01
Total fat (g)	8.00 ± 0.40	6.50 ± 0.38
Saturated Fatty Acids (% total fat)	37.69 ± 0.04	26.80 ± 0.05
Monounsaturated Fatty Acids (% total fat)	42.86 ± 0.06	58.76 ± 0.001
Polyunsaturated Fatty Acids (% total fat)	19.45 ± 0.02	14.45 ± 0.05
PUFA n6 (% total fat)	18.28 ± 0.05	13.42 ± 0.07
PUFA n3[†] (% total fat)	1.17 ± 0.03	1.03 ± 0.02
Cholesterol (mg)	34.9 ± 1.0	30.2 ± 1.0
Sodium (mg)	1,290 ± 50	650 ± 50
Calcium (mg)	24.4 ± 0.1	21.5 ± 0.1
Iron (mg)	1.2 ± 0.1	1.6 ± 0.1

[†]EPA or DHA no was determined.

was twice that of the standard version. Finally, the n6/n3 ratio of the new product was lower than that of the standard version (15.7% *vs* 13.0%). EPA and DHA were not determined.

Product intake by the subjects was 46-48 g, that is, practically the full amount offered, in all cases. Table II shows the data for the baseline and two supplemented diets. The energy contribution was around 58.9 kcal/day in the modified product (3.0% of total energy requirements) and 68.9 kcal/day in the standard product (3.6% of total energy requirements). Energy and protein intakes were higher after the dietary interventions, but were not significantly different from the baseline and within the range of the subjects' normal diet. Although the fat intake was similar in all three phases, MUFA was higher in both supplemented diets. The standard product provided 6.5% of total MUFA and the new product 7.1%. The macronutrient energy ratios were 18.7-21.8% (proteins), 44.3-46.2% (carbohydrates) and 33.0-35.0% (fats). These proportions are typical in the Spanish population.[50,51]

Table III
Anthropometric characteristics of the subjects participating in the study (mean ± standar deviation)

Parameter	*Man (n = 9)*	*Woman (n = 29)*	*Global (n = 38)*
Age (yr)	83.1 ± 4.7	81.7 ± 7.3	82.1 ± 6.7
Weight (kg)	74.5 ± 13.1	67.2 ± 16.7	69.1 ± 16.0
Height (cm)	165.8 ± 7.9	151.4 ± 4.0	155.1 ± 8.2
Body Mass Index	27.1 ± 4.2	29.3 ± 6.9	28.7 ± 6.3
Waist Circumference (cm)	105.6 ± 13.3	98.9 ± 12.7	100.6 ± 13.0
Leg Circumference (cm)	41.8 ± 4.1	44.7 ± 8.3	43.9 ± 7.5
Mid-arm Circumference (cm)	26.3 ± 2.7	27.3 ± 5.0	27.0 ± 4.5
Triceps Skinfold Thickness (mm)	9.9 ± 4.2	21.6 ± 4.5	18.6 ± 4.3

Anthropometrics, hematological and biochemical indexes

The subjects of both sexes were well matched with regard to baseline characteristics (table III). Table IV shows the main hematological and biochemical parameter values for the phases of the study (*basal,* that is, prior to dietary supplementation, *standard,* that is, after intake of the standard product and *modified,* that is, after intake

Table II
Estimated dietary intakes of the subjects at baseline and after dietary treatment containing standard or modified products (mean ± standard deviation)

Parameter	*Diet*		
	Basal (n = 38)	*standard product (n = 38)*	*modified product (n = 38)*
Energy (kcal)	1,862.3 ± 134.9	1,873.0 ± 160.0	1,914.4 ± 235.5
Proteins (g)	88.9 ± 26.2	99.0 ± 24.1	107.1 ± 23.7
Carbohydrates (g)	219.1 ± 12.6	211.6 ± 20.6	221.4 ± 26.6
Dietary fiber (g)	19.8 ± 5.0	20.7 ± 3.9	19.9 ± 4.0
Fats (g)	74.0 ± 8.8	74.2 ± 7.4	72.0 ± 8.1
Saturated Fatty Acids (g)	28.8 ± 5.0	28.4 ± 5.0	28.8 ± 6.3
Monounsaturated Fatty Acids (g)	23.3 ± 5.8	26.5 ± 5.0	27.1 ± 4.5
Polyunsaturated Fatty Acids (g)	7.6 ± 2.7	9.2 ± 2.5	7.9 ± 0.7
Cholesterol (mg)	335.1 ± 116.3	424.0 ± 156.0	403.6 ± 149.4
Iron (mg)	16.8 ± 7.5	17.1 ± 7.2	15.9 ± 3.5

Table IV
Hematologic and biochemical parameters of subjects according to dietary treatment (mean ± standard deviation)

Parameter	*Diet*		
	Basal (n = 38)	*standard product (n = 38)*	*modified product (n = 38)*
Hemoglobin (g/L)	135.1 ± 11.3	132.6 ± 12.2	133.7 ± 11.7
Red blood cells (10^{12}/L)	4.4 ± 0.4	4.3 ± 0.4	4.4 ± 0.5
Platelets (10^9/L)	232.3 ± 69.3	232.8 ± 76.3	245.8 ± 75.2
White blood cells (10^9/L)	7.4 ± 2.4	7.2 ± 3.4	7.9 ± 3.8
Neutrophils (10^9/L)	4.4 ± 1.6	4.2 ± 1.5	4.4 ± 1.5
Lymphocytes (10^9/L)	2.1 ± 1.7	2.3 ± 2.5	2.6 ± 2.5
Monocytes (10^8/L)	5.8 ± 0.3	5.5 ± 0.2	6.1 ± 0.2
Eosinophiles (10^8/L)	2.1 ± 0.2	2.0 ± 0.1	2.8 ± 0.4
Basophiles (10^8/L)	0.4 ± 0.3	0.4 ± 0.4	0.3 ± 0.2
Fasting glucose (mmol/L)	6.28 ± 1.79*	5.77 ± 1.33	5.42 ± 1.09*
Urea (mmol/L)	16.26 ± 5.64*	13.57 ± 3.71	16.31 ± 5.14*
Creatinine (μmol/L)	64.2 ± 19.7*	74.5 ± 23.7	87.9 ± 23.0*
Uric acid (μmol/L)	297.3 ± 79.7	275.2 ± 69.8	294.5 ± 81.7
Total cholesterol (mmol/L)	5.30 ± 0.82	5.00 ± 0.77	5.14 ± 0.92
LDL-cholesterol (mmol/L)	3.33 ± 0.66	3.17 ± 0.50	3.36 ± 0.69
HDL-cholesterol (mmol/L)	1.48 ± 0.08	1.50 ± 0.07	1.48 ± 0.10
Triacylglycerides (mmol/L)	1.10 ± 0.47	1.08 ± 0.51	1.27 ± 0.65
Apolipoprotein A1 (g/L)	1.51 ± 0.24	1.54 ± 0.37	1.39 ± 0.23
Apolipoprotein B (g/L)	1.19 ± 0.31	1.13 ± 0.26	1.17 ± 0.30
Lipoprotein (a) (μmol/L)	0.85 ± 0.89	0.97 ± 0.89	1.21 ± 1.20
Glutamic oxalacetic transaminase (U.I/L)	7.4 ± 1.8*	5.7 ± 1.6	5.9 ± 1.4[a]
Glutamic piruvic transaminase (U.I/L)	8.8 ± 1.9	9.5 ± 1.6	9.7 ± 1.2
γ-glutamil-transferase (U.I/L)	10.2 ± 5.4	9.4 ± 5.4	9.3 ± 4.5
C-Reactive protein (mmol/L)	92.6 ± 49.2	87.1 ± 31.6	88.0 ± 33.9
Iron (μmol/L)	9.95 ± 3.42*	13.52 ± 5.57	11.06 ± 3.39*
Transferrin (μmol Fe/L)	4.33 ± 0.14*	4.26 ± 0.11	4.24 ± 0.13
Retinol binding protein (μmol/L)	0.29 ± 0.08*	0.24 ± 0.07	0.25 ± 0.08
Prealbumin (μmol/L)	0.39 ± 0.07	0.37 ± 0.07	0.40 ± 0.11
Albumin (mmol/L)	0.54 ± 0.08	0.53 ± 0.06	0.52 ± 0.06

*Significantly different from value of diet supplemented with standard product ($p < 0.05$).

of the new product). Overall, there were no significant sex-related differences in hematological or biochemical indexes. The subjects' basal-phase hematological and biochemical values were typical for the elderly population (table IV). The present intervention shows that the decrease in the glucose concentration associated with both products was not statistically significant.

In terms of the protein metabolism markers (urea, creatinine and uric acid), a slight increase in creatinine was observed after the intake of the modified product ($p < 0.05$). There was a slight fall in blood urea after consumption of the standard product ($p < 0.05$) followed by a slight increase towards baseline levels after consumption of the new product. There was no variation in uric acid levels across the three phases ($p < 0.05$).

There was no significant variation in serum lipids (total cholesterol, LDL-cholesterol, HDL-cholesterol and triacylglycerides) between the three phases (table IV). Despite the values of lipoprotein concentrations (apo A1, apo B and lipoprotein α), shown in table IV, the differences were not statistically significant.

The GOT and retinol-binding protein concentrations were also observed to fall to baseline values after both the standard and modified product intake phases ($p < 0.05$), with no change in the albumin and prealbumin concentrations.

Finally, higher blood iron levels were observed in association with intake of both the standard and the modified product ($p < 0.05$).

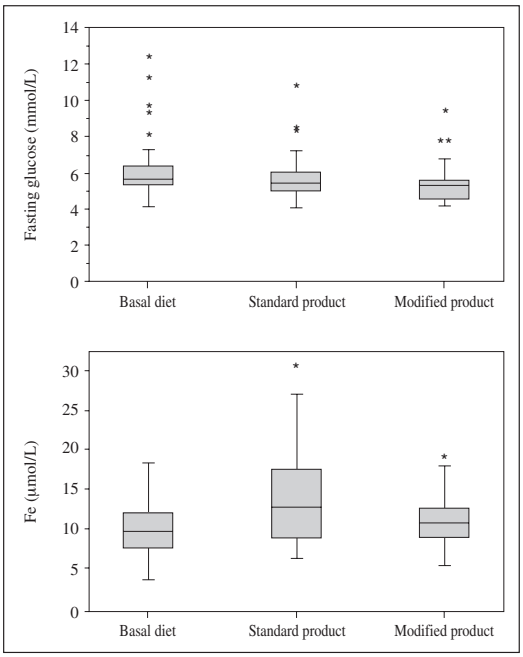

Fig. 1.—Box-plot charts for serum glucose and iron concentrations of subjects enrolled in present study (basal diet, basal diet with standard product and basal diet with experimental product).

Figure 1 shows the box-plots for the subjects' blood glucose and iron concentrations. A decrease in the dispersion of these values can be observed in association with the introduction of the modified product.

Discussion

Despite the presence of trained personnel during all dietary intervention sessions, 52% of the subjects withdrew from the trial due to loss of motivation or lack of appetite for the product served as an afternoon snack. Withdrawal occurred throughout the experiment and increased during the final two weeks. This population sample is characterized by a high average age and the various mild chronic conditions typical of this age cohort.

The subjects' weights and BMI exceeded the recommended values, but were similar to other studies of elderly Spanish institutionalized samples.[50,52,53] However, these values were slightly higher than reported for Northern European elderly people,[3,54,55] and similar to those described for elderly Italians.[56] The differences in BMI levels observed in this study and those reported elsewhere are greater in the case of the female subjects (29.3 ± 1.4), coinciding with findings from other studies in elderly Spanish subjects.[53,57] Some studies involving dietary supplementation in the elderly find no significant changes in BMI (8-10). Intake of the meat products did not modify the body weight of subjects in the present trial.

Taking into account that the aim of the trial was to verify the effect of the new meat product, the higher MUFA content does not appear to have altered the subjects' lipid profile, since LDL-cholesterol and HDL-cholesterol levels remained constant (table IV). These findings differ from those reported by other authors for diets with increased amounts of MUFA[22,23,28] or PUFA.[58,59] These findings indicate the need for further research on the lipid profile of fat content in food products and its relationship with the plasma lipid profile. The results reported here may reflect the age of this population.[31,60] The observed variations in lipoprotein (Apo A-I, Apo B and lipoprotein α) levels are unlikely to cause significant modifications in the subjects' nutritional status, since greater changes in these parameters would be necessary to cause variation in lipid profiles.

This 6-week trial introduced a new meat product into the diet of a sample of elderly people living in institutions, producing a statistically significant and clinically relevant effect, particularly in nutritional-status parameters such as urea, creatinine, GOT, iron, and retinol binding protein. No change was observed in the lipid profile, glucose or inflammatory status parameters.

The unexpectedly significantly lower decrease in the glucose level during the intake of the new product is surprising and calls for further research. The glycemic response could be related with high protein intake.[61,62] Another unexpected observation is the 25% to 30% increase in blood iron content, which is highly beneficial for the population concerned, particularly in light of the short duration of the trial.

The dietary intervention in this study involves the introduction of a dietary supplement nutritionally enriched with proteins and iron. In order to observe the effect of the ingestion of the full amount of supplement in combination with the subjects' usual dietary intake, the amounts of nutrients added to the diet were within the recommended dietary range. All previous research on the functional effect of nutritional supplements on institutionalized elderly people had used relatively short intervention periods, ranging from 4 weeks to 5 months.

The results for the hematological parameters (table IV), fall within the normal range for this population[63] and the fact that they remained close to baseline levels shows that they were unaffected by dietary intervention with either product. These results agree with Sanders et al[22] who found no change in hemostatic risk factors in elderly people after decreasing the n-6: n-3 to a similar 3:1.

A decrease in fasting glucose can be observed during the intake of both products. It is accepted that insulin resistance is linked to an age-related increase in adiposity.[64] Despite numerical differences in the values obtained across the three phases of the trial, there is no statistically significant variation. It would be interesting to check this effect in a longer trial on the same lines as the present study, particularly if a washout period were included.

In addition, the decrease in GOT concentration, indicating a beneficial effect on protein metabolism; the decrease in retinol-binding protein**;** and only minimal variation in albumin and pre-albumin concentrations, all suggest the dietary intervention used in the trial was positive.[65] Desroches et al.[66] found that a low-fat MUFA-enriched diet had no significant effect on C-reactive protein (CRP) plasma concentration, suggesting that the observed decreasing tendency of this parameter might be due to the fact that the diets differ less in their fat content than in their fatty acid profile. This is mainly due to the high oleic acid content of the new product, as prescribed for the Mediterranean dietary model[30,31] and recommended by the *Comité Español Interdisciplinario para la intervención Cardiovascular* - Spain's Interdisciplinary Committee for Cardiovascular Intervention.[32]

Finally, the high blood iron content observed in the subjects suggests the positive effect of these products on blood levels of this mineral. There was an observed trend towards lower hemoglobin levels with increasing age in this sample population. The dietary supplements administered to them appear to have checked this trend, bringing hemoglobin levels closer to the standards commonly proposed in national and international nutritional surveys. Many people with low hemoglobin are considered iron deficient, although the data are not always convincing. As a result, many nutritionists and medical authorities have recommended the iron enrichment of our foods.[67] Nevertheless, opinions are divided on this point.[68] The most common view is that there is no convincing proof of the effectiveness of iron-enrichment schemes. There is no evidence that the provision of iron supplements either in food or as ferrous sulfate capsules is effective in raising hemoglobin levels in the elderly.[69] However, the significant increase in serum iron and transferrin levels observed in this study demonstrate the iron-replenishing effect produced by the intake of the new meat product. This supports the recommendation that meat products should form part of the diet of the elderly and will not compromise the plasma lipid profile.

The results of the nutritional study of the new meat product show that only glucose, urea, creatinine, GOT, iron and retinol-binding protein, all of them nutritional status indicators, show any change from the baseline levels. It has been observed, overall, that intake of either the standard or the new product contributes to improve and equalize nutritional status across the sample, with little effect on blood lipid profiles, despite the higher monounsaturated oleic acid content of the new product.

We can conclude from these results that the standard product improves the protein status without changing the lipid profile (although the two products differed in fatty acid composition). Furthermore, the modified product is more effective than the standard one in improving the levels of some protein metabolism markers. This supports the conclusion that the introduction of a dietary supplement with the characteristics of the modified product improves the biochemical status of the subjects and equalize their population characteristics. It would seem that consumption of either product leads to health benefits for this elderly population. The present findings also indicate the desirability of further research into ways to achieve fast glucose reduction and serum iron increase, both of which can have a highly positive impact on the general health of the elderly.

Acknowledgments

Financial support was obtained from European Commission (FP6-2003- SME-1 CRAFT Nº 017554).

References

1. Van der Wielen RP, Van Heereveld HA, De Groot CPGM, Va Staveren WA. Nutritional status of elderly female nursing home residents; the effect of supplementation with a physiological dose of water-soluble vitamins. *Eur J Clin Nutr* 1995; 49 (9): 665-674.
2. Wouters-Wesseling W, Wouters AEJ, Kleijer CN, De Groot CP, Van Staveren WA. Study of the effect of a liquid nutrition supplement on the nutritional status of psycho-geriatric nursing home patients. *Eur J Clin Nutr* 2002; 56 (3): 245-251.
3. Manders M, De Groot L, Hoefnagels W, Dhonukshe-Rutten R, Wouters-Wesseling W, Mulders A et al. The effect of a nutrient dense drink on mental and physical function in institutionalized elderly people. *J Nutr Health Aging* 2009; 13 (9): 760-767.
4. Raynaud-Simon A. Virtual Clinical Nutrition University: Malnutrition in the elderly, Epidemiology and consequences. *Eur e-J Clinical Nut Metabol* 2009; 4 (2): e86-e89.
5. Faxén-Irving G, Andrén-Olsson B, Af Geijerstam A, Basun H, Cederholm T. The effect of nutritional intervention in elderly subjects residing in group-living for the demented. *Eur J Clin Nutr* 2002; 56 (3): 221-227.
6. De Jong N, Paw MJMCA, De Groot LCPGM, Cees de Graaf, Kok FJ, Van Staveren WA. Functional Biochemical and Nutrient Indices in Frail Elderly People Are Partly Affected by Dietary Supplements but Not by Exercise. *J Nutr* 1999*;* 129 (11): 2028-2036.
7. De Jong N, Paw MJCA, De Groot LC, Rutten RA, Swinkels DW, Kok FJ et al. Nutrient-dense foods and exercise in frail elderly: effects on B vitamins, homocysteine, methylmalonic acid, and neuropsychological functioning. *Am J Clin Nutr* 2001; 73 (2): 338-346.
8. Hogarth MB, Marshall P, Lovat LB, Palmer AJ, Frost CG, Fletcher AE et al. Nutritional Supplementation in Elderly Medical In-patients: A Double-blind Placebo-controlled Trial. *Age Ageing* 1996; 25 (6): 453-457.
9. Fiatarone MA, O'Neill EF, Ryan ND, Clements KM, Solares GR, Nelson ME et al. Exercise Training and Nutritional Supplementation for Physical Frailty in Very Elderly People. *N Engl J Med* 1994; 330 (25): 1769-1775.
10. Lauque S, Arnaud-Battandier F, Mansourian R, Guigoz Y, Paintin M, Nourhashemi F et al. Protein-energy oral supplementation in malnourished nursing-home residents. A controlled trial. *Age Ageing* 2000; 29 (1): 51-56.
11. Smoliner C, Norman K, Scheufele R, Hartig W, Pirlich M, Lochs H. Effects of food fortification on nutritional and functional status in frail elderly nursing home residents at risk of malnutrition. *Nutr* 2008; 24 (11-12): 1139-1144.
12. Karpe F. Postprandial lipemia—effect of lipid-lowering drugs. *Atheroscler Suppl* 2002; 3 (1): 41-46.
13. Lefevre M, Kris-Etherton PM, Zhao G, Tracy RP. Dietary fatty acids, hemostasis, and cardiovascular disease risk. *J Am Diet Assoc* 2004; 104 (3): 410-419.

14. Thomsen C, Rasmussen O, Lousen T, Holst JJ, Fenselau S, Schrezenmeir J et al. Differential effects of saturated and monounsaturated fatty acids on postprandial lipemia and incretin responses in healthy subjects. *Am J Clin Nutr* 1999; 69 (6): 1135-1143.
15. Tholstrup T, Sandstrom B, Bysted A, Holmer G. Effect of 6 dietary fatty acids on the postprandial lipid profile, plasma fatty acids, lipoprotein lipase, and cholesterol ester transfer activities in healthy young men. *Am J Clin Nutr* 2001; 73 (2): 198-208.
16. Zampelas A, Roche H, Knapper JME, Jackson KG, Tornaritis M, Hatzis C et al. Differences in postprandial lipaemic response between Northern and Southern Europeans. *Atherosclerosis* 1998; 139 (1): 83-93.
17. Roche HM, Gibney MJ. Effect of long-chain n-3 polyunsaturated fatty acids on fasting and postprandial triacylglycerol metabolism1. *Am J Clin Nutr* 2000; 71 (1): 232S-237S.
18. Rivellese AA, Maffettone A, Vessby B, Uusitupa M, Hermansen K, Berglund L et al. Effects of dietary saturated, monounsaturated and n-3 fatty acids on fasting lipoproteins, LDL size and post-prandial lipid metabolism in healthy subjects. *Atherosclerosis* 2003; 167 (1): 149-158.
19. Vessby B, Uusitupa M, Hermansen K, Riccardi G, Rivellese AA, Tapsell LC et al. Substituting dietary saturated for monounsaturated fat impairs insulin sensitivity in healthy men and women: The KANWU study. *Diabetologia* 2001; 44 (3): 312-319.
20. Lovegrove JA, Brooks CN, Murphy MC, Gould BJ, Williams CM. Use of manufactured foods enriched with fish oils as a means of increasing long-chain n?3 polyunsaturated fatty acid intake. *Br J Nutr* 1997; 78 (2): 223-236.
21. Finnegan YE, Minihane AM, Leigh-Firbank EC, Kew S, Meijer GW, Muggli R et al. Plant- and marine-derived n-3 polyunsaturated fatty acids have differential effects on fasting and postprandial blood lipid concentrations and on the susceptibility of LDL to oxidative modification in moderately hyperlipidemic subjects. *Am J Clin Nutr* 2003; 77 (4): 783-795.
22. Sanders TA, Lewis F, Slaughter S, Griffin BA, Griffin M, Davies I et al. Effect of varying the ratio of n-6 to n-3 fatty acids by increasing the dietary intake of α-linolenic acid, eicosapentaenoic and docosahexaenoic acid, or both on fibrinogen and clotting factors VII and XII in persons aged 45-70 y: the OPTILIP Study. *Am J Clin Nutr* 2006; 84 (3): 513-522.
23. Griffin MD, Sanders TA, Davies IG, Morgan LM, Millward DJ, Lewis F et al. Effects of altering the ratio of dietary n-6 to n-3 fatty acids on insulin sensitivity, lipoprotein size, and postprandial lipemia in men and postmenopausal women aged 45-70 y: the OPTILIP Study. *Am J Clin Nutr* 2006; 84 (6): 1290-1298.
24. Resurreccion AVA. Sensory aspects of consumer choices for meat and meat products. *Meat Sci* 2004; 66 (1): 11-20.
25. Webb E, O'Neill H. The animal fat paradox and meat quality. *Meat Sci* 2008; 80 (1): 28-36.
26. Katan M, Zock P, Mensink R. Effects of fats and fatty acids on blood lipids in humans: an overview. *Am J Clin Nutr* 1994; 60 (6): 1017S-1022.
27. Katan M, Zock P, Mensink R. Dietary oils, serum lipoproteins, and coronary heart disease. *Am J Clin Nutr* 1995; 61 (6): 1368S-1373.
28. Pérez-Jiménez F, Espino A, López-Segura F, Blanco J, Ruiz-Gutiérrez V, Prada J et al. Lipoprotein concentrations in normolipidemic males consuming oleic acid- rich diets from two different sources: olive oil and oleic acid-rich sunflower oil. *Am J Clin Nutr* 1995; 62 (4): 769-775.
29. Rodenas S, Rodríguez-Gil S, Merinero MC, Sánchez-Muniz FJ. Dietary Exchange of an Olive Oil and Sunflower Oil Blend for Extra Virgin Olive Oil Decreases the Estimate Cardiovascular Risk and LDL and Apolipoprotein AII Concentrations in Postmenopausal Women. *J Am Coll Nutr* 2005; 24 (5): 361-369.
30. Carrero JJ, Fonolla J, Marti JL, Jiménez J, Boza JJ, López-Huertas E. Intake of Fish Oil, Oleic Acid, Folic Acid, and Vitamins B-6 and E for 1 Year Decreases Plasma C-Reactive Protein and Reduces Coronary Heart Disease Risk Factors in Male Patients in a Cardiac Rehabilitation Program. *J Nutr* 2007; 137 (2): 384-390.
31. Jackson KG, Armah CK, Doman I, James L, Cheghani F, Minihane AM. The impact of age on the postprandial vascular response to a fish oil-enriched meal. *Br J Nutr* 2009; 102 (10): 1414-1419.
32. De Lorgeril M, Salen P. The Mediterranean-style diet for the prevention of cardiovascular diseases. *Public Health Nutr* 2006; 9 (1a): 118-123.
33. Serra-Majem L, Roman B, Estruch R. Scientific Evidence of Interventions Using the Mediterranean Diet: A Systematic Review. *Nutr Rev* 2006, 64 (s1): S27-S47.
34. Lichtenstein AH, Appel LJ, Brands M, Carnethon M, Daniels S, Franch HA et al. Diet and Lifestyle Recommendations Revision 2006: A Scientific Statement From the American Heart Association Nutrition Committee. *Circulation* 2006; 114 (1): 82-96.
35. Brotons C, Royo-Bordonad MA, Álvarez-Sala L, Armario P, Artigao R, Conthe P et al. Adaptación española de la Guía Europea de Prevención Cardiovascular. *Clin Invest Arterioscl* 2005; 17 (1): 19-33.
36. Larsen CS. Animal Source Foods and Human Health during Evolution. *J Nutr* 2003; 133 (11): 3893S-3897.
37. Burr M, Sweetnam P. Vegetarianism, dietary fiber, and mortality. *Am J Clin Nutr* 1982; 36 (5): 873-877.
38. Snowdon D. Animal product consumption and mortality because of all causes combined, coronary heart disease, stroke, diabetes, and cancer in Seventh-day Adventists. *Am J Clin Nutr* 1988; 48 (3): 739-748.
39. Milman N, Pedersen A, Ovesen L, Schroll M. Iron status in 358 apparently healthy 80-year-old Danish men and women: relation to food composition and dietary and supplemental iron intake. *Ann Hematol* 2004; 83 (7): 423-429.
40. Vellas B, Albarede J, Garry P. Diseases and aging: patterns of morbidity with age; relationship between aging and age-associated diseases. *Am J Clin Nutr* 1992; 55 (6): 1225S-1230.
41. Smith SM, Mathews Oliver SA, Zwart SR, Kala G, Kelly PA, Goodwin JS et al. Nutritional Status Is Altered in the Self-Neglecting Elderly. *J Nutr* 2006; 136 (10): 2534-2541.
42. Donini LM, Savina C, Rosano A, Cannella C. Systematic Review of Nutritional Status Evaluation and Screening Tools in the Elderly. *J Nutr Health Aging* 2007; 11 (5): 421-432.
43. Vellas B, Villars H, Abellan G, Soto ME, Rolland Y, Guigoz Y et al. Overview of the MNA? Its History and Challenges. *J Nutr Health Aging* 2006; 10 (6): 456-462.
44. World Health Organization. Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. WHO Technical Report Series 1995. No. 854. Geneva (Switzerland).
45. Lizaso G, Chasco J, Beriain MJ. Microbiological and biochemical changes during ripening of salchichon, a Spanish dry cured sausage. *Food Microbiol* 1999; 16 (3): 219-228.
46. Petron MJ, García-Regueiro JA, Martin L, Muriel E, Antequera T. Identification and Quantification of Cholesterol and Cholesterol Oxidation Products in Different Types of Iberian Hams. *J Agric Food Chem* 2003; 51 (19): 5786-5791.
47. Jorhem L. Determination of Metals in Foods by Atomic Absorption Spectrometry after Dry Ashing: NMKL1 Collaborative Study. *J AOAC Int* 2000; 83 (5): 1204-1211.
48. Allain CC, Poon LS, Chan CSG, Richmond W, Fu PC. Enzymatic Determination of Total Serum Cholesterol. *Clin Chem* 1974; 20 (4): 470-475.
49. Bucolo G, David H. Quantitative Determination of Serum Triglycerides by the Use of Enzymes. *Clin Chem* 1973; 19 (5): 476-482.
50. García-Arias M, Villarino A, García-Linares M, Rocandio A, García-Fernández M. Daily intake of macronutrients in a group of institutionalized elderly people in León. Spain. *Nutr Hosp* 2003; 18 (2): 87-90.
51. Soriguer F, Almaraz MC, Garcia-Almeida JM, Cardona I, Linares F, Morcillo S et al. Intake and home use of olive oil or mixed oils in relation to healthy lifestyles in a Mediterranean population. Findings from the prospective Pizarra study. *Br J Nutr* 2010; 103 (01): 114-122.
52. Jiménez M, Fernández C, Verduga R, Crespo D. Valores antropométricos en una población institucionalizada muy anciana. *Nutr Hosp* 2002; 17 (5): 244-250.

53. Lasheras C, González C, Patterson AM, Fernández S. Food Habits and Anthropometric Measurements in a Group of Independent and Institutionalized Elderly People in Spain. *J Nutr Sci Vitaminol* 1998; 44 (6): 757-768.
54. Bannerman E, Reilly JJ, MacLennan WJ, Kirk T, Pender F. Evaluation of validity of British anthropometric reference data for assessing nutritional state of elderly people in Edinburgh: cross sectional study. *BMJ* 1997; 315 (7104): 338-341.
55. Dey DK, Rothenberg E, Sundh V, Bosaeus I, Steen B. Height and body weight in the elderly. I. A 25-year longitudinal study of a population aged 70 to 95 years. *Eur J Clin Nutr* 1999; 53 (12): 905-914.
56. Perissinotto E, Pisent C, Sergi G, Grigoletto F, Enzi G. Anthropometric measurements in the elderly: age and gender differences. *Br J Nutr* 2002; 87 (02): 177-186.
57. Gutiérrez-Fisac JL, López E, Banegas JR, Graciani A, Rodriguez-Artalejo F. Prevalence of Overweight and Obesity in Elderly People in Spain. *Obesity* 2004; 12 (4): 710-715.
58. Stewart JW, Kaplan ML, Beitz DC. Pork with a high content of polyunsaturated fatty acids lowers LDL cholesterol in women. *Am J Clin Nutr* 2001; 74 (2): 179-187.
59. Goyens PLL, Mensink RP. Effects of alpha-linolenic acid versus those of EPA//DHA on cardiovascular risk markers in healthy elderly subjects. *Eur J Clin Nutr* 2006; 60 (8): 978-984.
60. Vandal M, Freemantle E, Tremblay-Mercier J, Plourde M, Fortier M, Bruneau J et al. Plasma Omega-3 Fatty Acid Response to a Fish Oil Supplement in the Healthy Elderly. *Lipids* 2008; 43 (11): 1085-1089.
61. Moghaddam E, Vogt JA, Wolever TMS.. The Effects of Fat and Protein on Glycemic Responses in Nondiabetic Humans Vary with Waist Circumference, Fasting Plasma Insulin, and Dietary Fiber Intake. *J Nutr* 2006; 136 (10): 2506-2511.
62. Karamanlis A, Chaikomin R, Doran S, Bellon M, Bartholomeusz FD, Wishart JM et al. Effects of protein on glycemic and incretin responses and gastric emptying after oral glucose in healthy subjects. *Am J Clin Nutr* 2007; 86 (5): 1364-1368.
63. Tsang CW, Lazarus R, Smith W, Mitchell P, Koutts J, Burnett L. Hematological indices in an older population sample: derivation of healthy reference values. *Clin Chem* 1998; 44 (1): 96-101.
64. Karakelides H, Irving BA, Short KR, O'Brien P, Nair KS. Age, Obesity, and Sex Effects on Insulin Sensitivity and Skeletal Muscle Mitochondrial Function. *Diabetes* 2010; 59 (1): 89-97.
65. Fuhrman MP, Charney P, Mueller CM. Hepatic proteins and nutrition assessment. *J Am Diet Assoc* 2004; 104 (8): 1258-1264.
66. Desroches S, Archer WR, Paradis M, Deriaz O, Couture P, Bergeron J et al. Baseline Plasma C-Reactive Protein Concentrations Influence Lipid and Lipoprotein Responses to Low-Fat and High Monounsaturated Fatty Acid Diets in Healthy Men. *J Nutr* 2006; 136 (4): 1005-1011.
67. Villarino A, García-Linares MC, García-Fernández MC, García-Arias MT. Evaluación dietética y parámetros bioquímicos de minerales en un colectivo de ancianos de la provincia de León (España). *Nutr Hosp* 2003; 18 (1): 39-45.
68. García-Arias MT, Villarino A, García-Linares MC, Rocandio AM, García-Fernández MC. Iron, folate and vitamins B 12 & C dietary intake of an elderly institutionalized population in León, Spain. *Nutr Hosp* 2003; 18 (4): 222-225.
69. Gershoff S, Brusis O, Nino H, Huber A. Studies of the elderly in Boston. I. The effects of iron fortification on moderately anemic people. *Am J Clin Nutr* 1977; 30 (2): 226-234.