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Short Communication

Effect of lean red meat from lamb *v.* lean white meat from chicken on the serum lipid profile: a randomised, cross-over study in women

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Abstract

The main dietary guidelines recommend restricting total and saturated fat intake in the management of high blood cholesterol levels for cardiovascular risk. These recommendations are usually oversimplified by considering that all red meats should be limited and replaced by white meats. However, lean red meat can be as low in fat as white meat. We examined the effects of red meat (lean breed lamb) and lean white meat (chicken) intake on the lipid profile of a group of women with stable life conditions (nuns living in convents). An open-label, randomised, cross-over study was carried out in thirty-six nuns who consumed either lamb or chicken three times per week for 5-week periods with their usual diet. Clinical, dietary and biochemical variables were evaluated at baseline and the end of each diet period. A validated FFQ was used to assess nutrient intake and monitor compliance. The results showed neither between-diet differences in lipid responses nor differences from baseline in total cholesterol, LDL-cholesterol or TAG for any diet period. In conclusion, consumption of lean red meat (lamb) or lean white meat (chicken) as part of the usual diet is associated with a similar lipid response. These two foods can be exchanged in a healthy diet to increase palatability.

Key words: Diets: Red meats: White meats: Serum lipids: LDL-cholesterol

The main dietary guidelines for the prevention of CVD, as those developed by the National Cholesterol Education Program, recommend the restriction of total fat to less than 30% of energy intake and SFA to less than 8–10%[1,2]. These guidelines include a wide variety of food recommendations, but they are usually oversimplified in order to achieve a low SFA intake[1,2]. Red meat, which is considered to be rich in total fat and SFA, is one of the main foods restricted in these guidelines[3]. However, the fat component of different meats is extremely variable. Different factors related to the animal source of the meat, such as breed, feedstock, processing and the particular meat cut influence both fat quantity and quality of the final product. In fact, lean red meat can be as low as or lower in SFA than white meat[4] and have a similar effect on lipid concentrations[5].

It is well known that the limitation in the variety of food choices may reduce the long-term adherence to dietary recommendations[5]. In many areas of the world, including the Aragon region in Spain, lamb is a common staple and a good dietary source of protein. Traditionally, lamb meat has been considered rich in fat, therefore being restricted or even prohibited when giving dietary advice for the treatment of hypercholesterolaemia. However, both genetic and feeding characteristics determine large differences in fat content among lamb species. A recent study has shown that a lamb breed bred in Spain and widely consumed, named 'Rasa Aragonesa', has a low cholesterol (55·8 mg/100 g) and SFA content

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(4·12 g/100 g) of the tested lamb, as reported by Sañudo and co-workers[6,7]. However, there are no studies specifically examining the effect of lamb consumption on blood lipid concentrations in human subjects. Therefore, we designed a study to examine the effects of the incorporation in the usual diet of lean red meat (leg and shoulder of lamb) and lean white meat (chicken) on blood lipids in a group of nuns living in convents.

Materials and methods

Study subjects

Nuns (n 36) aged ≥18 years from four different convents in the Zaragoza area (north-eastern Spain) were recruited into a protocol approved by the ethics committee of our institution (Comité de Investigación Clínica de Aragón) and provided written informed consent. The study was conducted according to the guidelines laid down in the Declaration of Helsinki. All nuns living in these four convents were invited to participate in the study and all of them accepted. Exclusion criteria were uncontrolled hypothyroidism and type 2 diabetes (HbA1c > 8 %), or any other disease that could interfere with the ability to comply with the study protocol. Stable treatment with oral antidiabetic agents or lipid-lowering medication was not a reason for exclusion. Nuns were offered free meat during the study period but no monetary compensation. Meat was purchased from the largest slaughterhouse in Zaragoza.

Dietary intervention

Women were randomised in a cross-over design between two diet sequences for 5-week periods: a diet including leg and shoulder from the lamb of Rasa Aragonesa breed (a medium-wool breed, rustic type of sheep raised for its meat, with the protected origin label 'Ternasco de Aragon' from Spain[6,7]) three times per week, and a diet including chicken (breast or leg) three times per week. All nuns in the study had daily meals prepared at their convent's kitchen, a reason why before the study began, a nutritionist visited the convents' cooks to instruct them on portion sizes and how to cook the two meats with the same recipes, which include identical ingredients (except the meat) and procedure of cooking (grilled, roasted and stewed) to minimise nutritional differences. Also, participants were advised to maintain their usual dietary patterns and physical activity level throughout the study. At the randomisation visit (week 0), participants were instructed to consume 125 g of meat, 3 d/week, for 5 weeks. Because diet-induced lipoprotein changes stabilise in <4 weeks[8], we did not incorporate a washout period between the diets. At week 5, participants crossed over to the alternate diet sequence, thus those who started with lamb switched to chicken and vice versa. Of the four convents, two started with lamb consumption and the other two with chicken.

Study variables were evaluated at three time points (weeks 0, 5 and 10 of the intervention period). Clinical parameters included the following: medical history, side effects, anthropometric measures (weight, height and waist circumference) and blood pressure. Fasting blood samples for biochemical profiles were drawn at the three visits. Dietary assessment consisted on a validated FFQ based on the previous month that was performed at baseline and after the lamb and chicken diets[9]. At the same time, physical activity was also evaluated through a validated questionnaire[10] and life-quality and satisfaction questionnaires were complemented by the participants at the end of the study.

Dietary compliance

The nutritionist visited the convents twice per week to reinforce dietary compliance. Participants' compliance with the diets was analysed by a 3 d food record intake during each meat period. Kitchen records were filled in by the cooks of each convent to ensure fulfilment of the correct recipes. Compliance with meat intake was also evaluated from self-reports in the food records. The nutritional content of the diets was estimated from Spanish food composition tables.

Laboratory measurements

Serum and EDTA plasma samples were stored at −80°C and analysed for each participant at the end of the study. Cholesterol and TAG levels were determined by standard enzymatic methods. HDL- and LDL-cholesterol levels were measured directly by an enzymatic reaction using cholesterol oxidase (UniCel DxC 800; Beckman Coulter, Inc., Brea, CA, USA). ApoB and C-reactive protein were determined by IMMAGE kinetic nephelometry (Beckman-Coulter, Inc.) and lipoprotein(a) by using turbidimetry.

Statistical analyses

The present feeding trial was designed as a non-inferiority study, considering the LDL-cholesterol level as a driven variable and assuming an equal effect of both interventions on LDL-cholesterol (less than 5 % difference) with a power of 90 %. Furthermore, the expected response to both treatments was estimated to be about 23 %, according to previous research experience, and almost no losses were expected, so the calculated sample size was eighteen individuals in each group. Statistical analyses were carried out including all individuals together because the four groups were very homogeneous, no significant differences in main study variables were found among them and treatment order did not influence the results. Diet effects on study outcomes were evaluated by repeated-measures ANOVA or the Friedman test, as appropriate. When significant differences were detected, multiple comparisons were made by using the Bonferroni correction for normally distributed variables or the Wilcoxon test for paired samples for variables with a skewed distribution to check between which periods differences occurred. In those variables in which multiple comparisons using Bonferroni were performed, a significance level corrected by Bonferroni

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(α/combination number; 0·05/3 = 0·016) has been used because of this test influence in sample size calculation; therefore, statistical significance was considered when $P<0·016$. The significance was set at $P<0·05$ for the rest of the variables. Data are presented as means and standard deviations for continuous variables, or medians and interquartile ranges for those with a skewed distribution. All statistical analyses were performed with SPSS software (version 15.0; SPSS, Chicago, IL, USA).

Results

Clinical characteristics

The study group was initially composed of thirty-six women, but two of them abandoned the study for personal reasons shortly after starting the first dietary period and were excluded from further analyses. The median age of participants was 71 (interquartile range 33–79) years and most of them were overweight or obese, with a mean BMI of 30·1 (SD 5·15) kg/m^2. Of these women, three had well-controlled type 2 diabetes: two of them were treated with metformin and one received only dietary treatment. None of them were smokers and the median physical activity level was normal for the participants' age, without changes during the intervention. Body weight decreased slightly from baseline after the lamb and chicken diet period (Table 1). There were no changes in blood pressure during the study.

Energy and nutrient intake

As presented in Table 1, the FFQ performed showed that the baseline diet had a relatively high content of healthy foods such as vegetables, fruits, olive oil and fish, but also of less healthy foods such as total dairy and meat products. The mean total energy intake was close to 2500 kcal/d (8368 kJ/d), with a high fat content and a high proportion of MUFA reaching almost 20 % of total energy intake, which is characteristic of Mediterranean populations and is ascribable to the high consumption of olive oil.

Total energy intake and the distribution of total carbohydrate, protein and fat were similar to baseline values after either the lamb or chicken diet period. The intervention increased the amount of meat (including both meats supplied in the study) by about 20 % and decreased the amount of fish consumed, explaining in part the decrease in PUFA after the lamb and chicken diet periods. Baseline meat intake was almost zero for lamb and 34·6 (SD 8·2) g/d for chicken.

Lipids and lipoproteins

The serum concentrations of lipids, apoB and lipoprotein(a) at baseline and after the lamb and chicken diet periods are presented in Table 1. There were neither between-diet differences nor differences from baseline for total and LDL-cholesterol, TAG, apoB or lipoprotein(a). However, there was a minor but significant decrease in HDL-cholesterol from baseline, which was independent from the type of meat consumed. Comparing the effect of both diets between them, there were no statistical differences either (data not shown). The effect of the type of meat on lipid responses was similar when assessed by baseline LDL-cholesterol (above or below 1600 mg/l) or age (above or below 70 years; data not shown).

Other biochemistry variables

None of the haematological and glucose control, liver and kidney function variables was affected by the dietary treatments (data not shown), except for serum uric acid concentrations, which increased from 48·6 (SD 11·4) mg/l at baseline to 54·5 (SD 16·9) mg/l and 52·2 (SD 15·9) mg/l after the lamb and chicken diet periods, respectively ($P<0·001$). Serum C-reactive protein concentrations did not differ between the diets but were reduced from baseline after the lamb diet (Table 1).

Side effects and satisfaction questionnaire

There were no relevant adverse events during the study. The results of the satisfaction questionnaire showed that both meat types were highly accepted among the participants, with median values of 8 and 9 (in an acceptance scale from 0 (worse) to 10 –(best)) for lamb and chicken, respectively, with no between-meat differences ($P=0·277$). When they were asked about the meat, 66·7 % preferred lamb, 27·3 % chicken and 6 % either one.

Discussion

The main conclusion of the present study is that consumption of leg and shoulder of Rasa Aragonesa lamb three times per week within a background Mediterranean diet results in a similar lipid profile to that associated with consumption of the same amount of chicken. Total and LDL-cholesterol concentrations after the two meat diet periods were similar to baseline values. The present results are not unexpected given the low SFA content of the lamb meat[6,7]. This SFA content is close to that reported for white meats such as chicken, which probably explains the similar lipid responses in the present study[11]. The present results concur with those of prior nutrition studies using lean meats. Scott *et al.*[12] found the same effects of lean beef or chicken on the lipid profile of hypercholesterolaemic subjects. Also, Hunninghake *et al.*[5] obtained similar results with lean red meat or lean white mean in subjects with hypercholesterolaemia. Both meats produced a slight decrease in HDL-cholesterol and weight. However, these effects were due to changes in both parameters in a small group of participants, and they are probably related to a better compliance with dietary recommendations in overweight subjects during the study.

The study population of nuns is an important strength of the present study. First, elderly obese women without other cardiovascular risk factors are most susceptible to nutritional counselling and intervention according to cardiovascular prevention guidelines[1,13]. Second, because of their healthy

Table 1. Daily intake of main foods and nutrients, body weight and biochemical variables at baseline and after the lamb and chicken diets

(Mean values and standard deviations, medians and interquartile ranges)

	Baseline		Lamb diet		Chicken diet		
	Median	Interquartile range	Median	Interquartile range	Median	Interquartile range	*P* †
Daily intake of selected foods							
Vegetables (g)	501	439–523	569	387–794	520	418–536	0·069
Fruits (g)	187	135–312	262*	246–429	237	148–286	<0·001
Olive oil (g)							
Mean		36·8		42·6		40·9	0·296
SD		21·5		18·0		17·5	
Dairy products (g)							
Mean		354		349		364	0·582
SD		158		125		113	
Meat products (g)	115	97–161	138*	117–160	131	128–156	0·371
Fish (g)	51	47–103	34*	25–111	34*	29–64	<0·001
Daily intake of energy and nutrients							
Total energy							
kcal	2464	1907–3326	2493	2202–2857	2382	2152–2807	0·244
kJ	10 309·37	7978·88–13 915·98	10 430·71	9213·16–11 953·68	9966·28	9003·96–11 744·48	
Protein (%)							
Mean		14·6		14·2		14·4	0·095
SD		1·16		1·97		38·0	
Carbohydrate (%)	39·6	37·6–44·0	42·3	38·9–44·4	41·7	38·6–46·9	0·510
Total fibre (g)							
Mean		25·9		26·0		23·6	0·054
SD		9·34		6·61		4·20	
Fat (%)	45·6	41·1–47·2	43·8	41·8–47·1	43·1	39·0–46·0	0·402
SFA							
Mean		11·3		10·5		11·9	0·076
SD		1·09		1·25		2·81	
MUFA							
Mean		19·3		21·1		19·9	0·215
SD		3·91		4·36		3·75	
PUFA	8·6	7·4–10·3	6·1*	5·6–7·4	6·6*	5·9–7·5	<0·001
Cholesterol (mg)	399	313–494	375	295–466	410	358–469	0·439
Weight and biochemical variables							
Weight (kg)	67·4	59·5–75·0	67·2	58·2–73·9	66·8	59·1–74·9	0·002
Total cholesterol (mg/l)							
Mean		1940		1950		1950	0·895
SD		60·7		71·1		60·8	
TAG (mg/l)	660	420–900	580	430–915	630	495–1030	0·529
HDL-cholesterol (mg/l)							
Mean		554		526**		518**	0·009
SD		19		17		17	
LDL-cholesterol (mg/l)							
Mean		1160		1190		1190	0·463
SD		58		64		54	
ApoB (mg/l)							
Mean		848		868		870	0·458
SD		38		42		36	
Lipoprotein(a) (mg/l)	197	77–764	174	90–609	209	75–587	0·150
CRP (mg/l)	0·36	0·10–0·69	0·33*	0·14–0·50	0·38	0·12–0·70	0·224

Values were significantly different among the three phases for the lamb or chicken diet when compared with baseline values: *$P<0·05$, **$P<0·016$ (Bonferroni correction).

† *P* values calculated by ANOVA for repeated measures or the Friedman test, as appropriate. Multiple comparisons using the Bonferroni correction or the Wilcoxon test were applied if statistical differences were found.

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lifestyle, nutritional changes are among the most important measures, probably the only ones, to be recommended. Finally, the stable lifestyle of nuns and their use of a single source of foods during the study allowed optimal dietary control. In fact, uric acid concentrations, a good biomarker of meat consumption[14], increased after both meat periods. Dietary records also indicated good compliance with the intervention, reinforcing the validity of the results.

The present study has the limitation that results are only applicable to a special breed of lamb, particularly to leg and shoulder parts. Other parts of the same animal or the same parts from other lamb breeds might have a different fat composition and lipid effects when consumed. The lamb used in the present study is reared intensively and fed concentrate and cereal-based forage *ad libitum* until slaughtering (3 months of age). These features probably make the nutritional composition of the meat particularly low in SFA.

In conclusion, the present study shows a similar lipid response to consumption of lean red meat from lamb and lean white meat from chicken. The findings indicate that not all red meats are equal regarding lipid effects. Lean parts of particular breeds of lamb may be included among foods labelled as healthy when giving nutritional counselling for cardiovascular risk reduction. Such specific dietary recommendations adapted to local customs and products improve palatability and might thus enhance long-term compliance.

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