Changes in body composition and cardiovascular risk indicators in healthy Spanish adolescents after lamb- (Ternasco de Aragón) or chicken-based diets

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Abstract

Objective: To assess the effect of lamb consumption (Protected Geographical Indication (PGI), Ternasco de Aragón) on health indicators including body composition and cardiovascular risk indicators of healthy young Spanish students living in the area of Aragón, Spain.

Methodology: A randomized-controlled and cross-over trial (two periods of 8 weeks duration) assessing changes on body composition (body mass index and skinfold thicknesses) and cardiovascular risk indicators of 50 participants randomly assigned to follow a normocaloric diet with lamb (Ternasco de Aragón) or chicken. Body composition and serum cardiovascular risk profiles were measured both at baseline and follow-up.

Results: Healthy men (n = 22) and women (n = 28), aged 19.43 ± 0.85 years were studied. Suprailiac skinfold thickness and waist circumference significantly decreased (p < 0.05) in the lamb-consumption group compared to the chicken based diet group. No significant changes were observed in the rest of the variables in either group.

Tryglycerol and insulin serum concentrations significantly decreased (p < 0.05) in the lamb-consumption group compared to the chicken based diet group.

Conclusions: The results suggest that regular consumption of lamb (Ternasco de Aragón) can be integrated into a healthy, varied and well-balanced diet, as body composition and cardiovascular risk profile changes are similar or even healthier to those observed following chicken consumption.

(Nutr Hosp. 2013;28:726-733)
DOI:10.3305/nh.2013.28.3.6382


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Abbreviations

kg: Kilogram.
PGI: Protected Geographical Indication.
g: Gram.
h: Hours.
IPAQ-A: Adapted International Physical Activity Questionnaire.
cm: Centimeter.
mm: Millimeter.
BMI: Body mass index.
m: Meters.
∑ 6 skinfolds: Sum of the six measured skinfold thicknesses.
LDL: Low-density lipoprotein cholesterol.
HDL: High-density lipoprotein cholesterol.
SPSS: Statistical Package for the Social Sciences.
ANOVA: Analysis of Variance.
CLA: conjugated linoleic acid.
SFAs: saturated fatty acids.
PUFA: polyunsaturated fatty acids.
n-6/n-3 ratio: the omega 6 fatty acids to omega 3 fatty acids ratio.

Introduction

Obesity is a great public health concern in the Westernized world, especially among children and young people, with over 97 million US people classed as obese or overweight. In Spain, the prevalence of overweight and obesity among adolescents has increased from 13% and 16% in 1985 to 35% and 32% in 2000-2002, respectively.

Dietary fat intakes are considered to be a determinant factor to the development of obesity leading to the design of low-fat diets for weight control and management and/or weight reduction. Red meat, in particular lamb, is associated with high-total fat diets and high saturated fat content; therefore, public health recommendations encourage elimination or reduced lamb meat consumption. However, evidence suggests that plasma lipid profiles can be improved following a low-cholesterol diet including lean red meat as the major protein source; these studies compared lean red meat with fish or lean chicken in hypercholesterolemic individuals. The results of another study indicated weight loss and improved lipid profile when lean beef or chicken were the main dietary protein sources in a sample of overweight women.

The term Ternasco de Aragón, refers to a young lamb, fed with concentrated ad libitum and cereal straw, without distinction of sex, and corresponding to one of the following three native Spanish sheep breeds: Rasa Aragonesa, Ojinegra and Roya Bilbilitana. The Ternasco de Aragón is slaughtered with less than 90 days of life, and a carcass weight between 8.0 and 12.5 kilogram (kg). Products are regulated by the Protected Geographical Indicator (PGI) Ternasco de Aragón (Denominación Específica Ternasco de Aragón. Diputación General de Aragón 10 de Junio de 1989, M.A.P.A. 22 de Septiembre 1992), and therefore, meet the established requirements of quality (Cumplimiento de la Norma Europea E.N. 45.011. Diputación General de Aragón, 1999).

The main objective of the present study was to compare the change effect of lamb (Ternasco de Aragón) versus commercial chicken consumption on body composition and cardiovascular risk indicators as part of a usual and balanced diet.

Materials and methods

Population

Participants recruited were between 16 to 25 years of age (n = 50 participants, 22 men and 28 women). Three university accommodation halls, two of them in the city of Teruel and one in the city of Zaragoza (Spain), were the recruitment settings. A study information sheet on the nature and purpose of the study was given to all participants and supervisors. Once written consent was obtained, participants were considered for inclusion in the study. Eligibility criteria included: free of any chronic, metabolic, endocrine or nutrition-related disease. In the medical history participants were required to report medical treatment. No participant reported to be currently enrolled in a weight loss program, or currently be taking any medications known to have a lipid-lowering effect.

Ethics

The study was performed in accordance with the Helsinki Declaration 1961 (revision of Edinburgh 2000) and was approved by the Research Ethics Committee of the Government of Aragón (Spain). A written informed consent was obtained from all participants and from their parents for those younger than 18 years.

Experimental design

The study was a randomized-controlled and crossover trial consisting of two experimental periods with duration of 8 weeks respectively. Enrolled participants followed a normocaloric diet and were randomly assigned to a lamb (Ternasco de Aragón) or a chicken-based diet. The nutritional value of both diets was similar in both groups including sources of dietary proteins and fats. Participants following a chicken-based diet were instructed to consume 150 grams (g) of chicken, three times per week, and participants following a lamb-based diet were instructed to consume 150 g of boneless lamb (200 g with bones).
The consumption of lamb was comparable to the consumption of chicken in the average Spanish homes. To ensure harmonisation, product-rich diets were served during lunch time and with each chef of the 3 designated university accommodation halls were given instructions on the cooking methods. Cooking methods are presented in table I.

The study design is presented schematically in Figure 1. During the 2 weeks before the first period, researchers contacted with participants in the three university accommodation halls and obtained informed consent of them. And after this, the first visit was scheduled in the morning hours where the medical history was applied and the first assessment of cardiovascular risk (first blood draw following a 12-h overnight fast), anthropometric, blood pressure (systolic and diastolic blood pressure) and heart rate measures were undertaken. Following an 8-week period, participants were attended in the morning hours for a second visit and the second assessment of cardiovascular risk (second blood draw following a 12-h overnight fast), anthropometric, blood pressure (systolic and diastolic blood pressure) and heart rate measures were undertaken. Following the cross-over design, participants for the second 8-week period were crossed to the lamb (Ternasco de Aragón) or a chicken-based diet respectively.

Dietary assessment

To assess dietary compliance, participants were asked to complete four computer-assisted and self-administered 24 h dietary recall (HELENA-DIAT)\textsuperscript{8}. Two recalls were obtained at the beginning of the 8 weeks period (either in the lamb (Ternasco de Aragón) or a chicken-based diet) and further two recalls at the end of the 8 weeks period (either in the lamb (Ternasco de Aragón) or a chicken-based diet). One of these recalls was obtained at the beginning of the study in each group, in order to assess the previous habitual diet of participants of both groups. As part of the dietary compliance assessment, the 24 h dietary recall was done too, in a random day, at the middle of each period.

Physical activity assessment

Physical activity was assessed via a self-administered questionnaire namely the Adapted International Physical Activity Questionnaire (IPAQ-A),\textsuperscript{9} at the same time as the rest of measurements.

Washout period

A 5-week washout period took place after each experimental period to remove the possible residual effects of the preceding experimental diet on the blood variables tested\textsuperscript{7}. Adolescents were instructed to maintain...
were measured. When measuring relaxed arm circumference, the participant stood relaxed facing the observer, and the arm hanging freely at the side; the tape was passed around the arm at the level of the midpoint of the upper arm. For measurements of the flexed upper arm circumference (biceps circumference), the participant contracted the biceps as much as possible, and the tape was passed around the arm so that it touched the skin surrounding the maximum circumference. To measure the waist circumference, the tape was applied horizontally midway between the lowest rib margin and the iliac crest, near the level of the umbilicus, at the end of gentle expiration. The hip circumference measurement was taken at the point yielding the maximum circumference over the buttocks, with the tape held in a horizontal plane. Proximal thigh circumference was measured just below the gluteal fold and perpendicular to its long axis; the participant stood erect with the feet slightly apart and the body mass evenly distributed between both legs. The complete set of anthropometric measurements was performed three times, but not consecutively; all the anthropometric variables were measured in order and then repeated for a second and a third time.

Body mass index (BMI) was calculated as body weight (kg) divided by height (meters, m) squared. And as an index of total adiposity, the sum of the six measured skinfold thicknesses (∑ 6 skinfolds) were calculated.

Laboratory analyses

Blood samples (total: 4 blood samples) were drawn via venipuncture by a registered nurse after a 12 h overnight fast. Samples were immediately shipped to the Clinical Analysis Service, Laboratory of Biochemistry of the General Hospital “Obispo Polanco” of Teruel. Standardized hospital laboratory procedures were used to analyze samples for total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, and triacylglycerols representing the study’s measures of lipid profile. Glucose and insulin were also analyzed. Enzymatic methods using Synchro Systems, DXC 800, Beckman Coulter determined: total cholesterol (cholesterol oxidase), high-density lipoprotein (HDL) cholesterol (cholesterol esterase), glucose (glycerolkinase) and triacylglycerols (hydrolysis by lipase). Insulin was determined by radioimmunoassay (Axsym, Abbott Laboratories, Chicago, IL, USA).

Statistical analyses

All analyses were done using the Statistical Package for the Social Sciences (SPSS Version 15.0 for Windows; SPSS Chicago, ILC). Means and standard deviations were used to describe the magnitude and variability of outcomes. Outcome measures of partic-
ular interest included BMI, skinfold thicknesses, circumferences, sum of 6 skinfold thicknesses, blood lipid profile, glucose and insulin. The validity of the cross-over design was tested by a repeated measures model (Analysis of Variance, ANOVA), defining one two-level model, where the order of treatment was the between-participants factor and the differences in the dependent variables were the within-participants indicators. No significant differences in the studied variables were found indicating that the order did not affect the results of observed variables, with the exception of insulin. Group comparisons, i.e., the lamb (Ternasco de Aragón) or the chicken based diet were done with the parametric t-test for paired samples. The non-parametric Wilcoxon test was used for quantitative variables showing a non-Gaussian distribution. Changes of insulin levels were compared with the t-test for two independent groups. Findings were considered statistically significant at \( p < 0.05 \).

Results

Baseline characteristics of the study participants per experimental phase are presented in table II. Only one participant refused to be included in the study at the beginning of it, and before the assignment of experimental period. No participant dropped out from the study, and all of them followed a 100\% of compliance or had an acceptable compliance (did not follow the diet exactly as offered in the university accommodation halls, but made acceptable modifications from the diet). In these circumstances, the registered dieticians helped the participant to increase compliance.

BMI and the sum of the 6 skinfold thicknesses did not change significantly in either group (table III). However, suprailiac skinfold thickness (\( p = 0.007 \)) and waist circumference (\( p = 0.026 \)) significantly decreased after lamb consumption (table 3).

Regarding lipid profile changes, plasma total cholesterol, HDL cholesterol and LDL cholesterol changes in the chicken-consumption group was not significantly different from changes in the lamb-consumption group. However, triacylglicerol concentrations significantly (\( p = 0.015 \)) decreased after the lamb consumption (table IV).

Statistically significant changes in insulin levels over time were also found: the insulin significantly (\( p < 0.05 \))

### Table II

**Baseline subjects characteristics***

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Chicken group</th>
<th>Lamb group</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Age (y)</td>
<td>19.489 ± 0.89</td>
<td>19.54 ± 0.95</td>
<td>19.43 ± 0.85</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>167.070 ± 11.35</td>
<td>171.29 ± 8.70</td>
<td>163.17 ± 12.25</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>65.132 ± 11.93</td>
<td>68.41 ± 11.51</td>
<td>62.10 ± 11.72</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.0760 ± 3.55</td>
<td>23.46 ± 3.25</td>
<td>22.71 ± 3.84</td>
</tr>
</tbody>
</table>

*Data presented as mean ± standard deviation.
BMI: Body mass index.

### Table III

**Body composition values: before and after the two interventions***

<table>
<thead>
<tr>
<th></th>
<th>Chicken (n = 50)</th>
<th>Ternasco de Aragón (n = 50)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>23.15 ± 3.57</td>
<td>23.25 ± 3.61</td>
</tr>
<tr>
<td>Skinfolds (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biceps</td>
<td>7.71 ± 3.26</td>
<td>8.16 ± 3.54</td>
</tr>
<tr>
<td>Triceps</td>
<td>14.35 ± 6.06</td>
<td>14.95 ± 6.38</td>
</tr>
<tr>
<td>Subscapular</td>
<td>12.55 ± 4.47</td>
<td>13.32 ± 5.89</td>
</tr>
<tr>
<td>Suprailiac</td>
<td>12.26 ± 6.22</td>
<td>12.90 ± 6.14</td>
</tr>
<tr>
<td>Thigh</td>
<td>20.52 ± 7.47</td>
<td>21.66 ± 7.84</td>
</tr>
<tr>
<td>Calf</td>
<td>15.33 ± 6.47</td>
<td>15.41 ± 6.37</td>
</tr>
<tr>
<td>Σ 6 skinfolds</td>
<td>80-10 ± 26.57</td>
<td>85.47 ± 28.93</td>
</tr>
<tr>
<td>Circumferences (cm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm</td>
<td>28.00 ± 3.29</td>
<td>28.14 ± 3.25</td>
</tr>
<tr>
<td>Biceps</td>
<td>29.25 ± 3.72</td>
<td>29.34 ± 3.58</td>
</tr>
<tr>
<td>Waist</td>
<td>79.29 ± 8.74</td>
<td>79.85 ± 8.82</td>
</tr>
<tr>
<td>Hip</td>
<td>97.49 ± 7.34</td>
<td>97.70 ± 7.16</td>
</tr>
<tr>
<td>Proximal high</td>
<td>56.88 ± 5.08</td>
<td>56.43 ± 4.83</td>
</tr>
</tbody>
</table>

*Data presented as mean ± standard deviation.
**p < 0.05 for changes over time.
BMI: Body mass index.
Σ 6 skinfolds, sum of six skinfolds.
Triacylglycerols (mg/dL) 72.30 ± 36.40 75.98 ± 52.76 4.23 ± 43.22 77.68 ± 32.54 67.45 ± 32.71 -8.85 ± 20.43**
Total cholesterol (mg/dL) 163.76 ± 29.45 166.92 ± 37.19 2.08 ± 19.26 164.82 ± 33.10 162.55 ± 31.67 0.31 ± 21.77
HDL colesterol (mg/dL) 49.52 ± 12.81 49.24 ± 12.24 -0.59 ± 8.89 48.39 ± 13.38 49.06 ± 12.57 0.67 ± 8.31
LDL colesterol (mg/dL) 93.94 ± 26.04 96.14 ± 29.25 2.20 ± 16.91 99.24 ± 27.19 92.71 ± 27.19 -6.53 ± 15.43
CT/HDL 3.50 ± 1.06 3.53 ± 0.94 0.01 ± 0.56 3.65 ± 1.09 3.52 ± 1.11 -0.10 ± 0.60
Systolic BP 119.75 ± 13.80 119.29 ± 14.10 -0.45 ± 8.15 120.19 ± 13.84 119.35 ± 11.48 -0.80 ± 9.59
Diastolic BP 75.16 ± 11.40 76.98 ± 13.28 1.82 ± 11.33 73.28 ± 11.53 74.80 ± 12.15 1.52 ± 11.92
Heart rate 75.16 ± 11.40 76.98 ± 13.28 1.82 ± 11.33 73.28 ± 11.53 74.80 ± 12.15 1.52 ± 11.92
Glucose (mg/dL) 78.44 ± 6.16 79.70 ± 7.36 1.61 ± 5.78 79.84 ± 7.35 79.27 ± 8.80 -0.63 ± 7.19
Insulin (μU/mL) 7.67 ± 3.62 8.38 ± 5.80 0.80 ± 5.52 8.49 ± 3.89 7.06 ± 3.19 -1.43 ± 3.89**

**p < 0.05 for changes over time.
*Data presented as mean ± standard deviation.
HDL: High-density lipoprotein; LDL: Low-density lipoprotein; CT/HDL: Total cholesterol/high-density lipoprotein quotient; Systolic BP: Systolic blood pressure; Diastolic BP: Diastolic blood pressure.

Changes in body composition and cardiovascular risk indicators in healthy Spanish adolescents

Table IV
Cardiovascular risk factors: before and after the two interventions*

<table>
<thead>
<tr>
<th></th>
<th>Chicken (n = 50)</th>
<th>Ternasco de Aragón (n = 50)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>Total cholesterol</td>
<td>163.76 ± 29.45</td>
<td>166.92 ± 37.19</td>
</tr>
<tr>
<td>Triacylglycerols</td>
<td>72.30 ± 36.40</td>
<td>75.98 ± 52.76</td>
</tr>
<tr>
<td>HDL colesterol</td>
<td>49.52 ± 12.81</td>
<td>49.24 ± 12.24</td>
</tr>
<tr>
<td>LDL colesterol</td>
<td>93.94 ± 26.04</td>
<td>96.14 ± 29.25</td>
</tr>
<tr>
<td>CT/HDL</td>
<td>3.50 ± 1.06</td>
<td>3.53 ± 0.94</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>119.75 ± 13.80</td>
<td>119.29 ± 14.10</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>69.25 ± 7.08</td>
<td>70.35 ± 7.12</td>
</tr>
<tr>
<td>Heart rate</td>
<td>75.16 ± 11.40</td>
<td>76.98 ± 13.28</td>
</tr>
<tr>
<td>Glucose (mg/dL)</td>
<td>78.44 ± 6.16</td>
<td>79.70 ± 7.36</td>
</tr>
<tr>
<td>Insulin (μU/mL)</td>
<td>7.67 ± 3.62</td>
<td>8.38 ± 5.80</td>
</tr>
</tbody>
</table>

*Data presented as mean ± standard deviation.

Discussion

Young age and adolescence are considered to be critical periods for the onset of obesity and obesity-associated morbidity in later life mainly because of fat depot localization in the abdominal region. A rather reliable anthropometric marker of abdominal obesity is waist circumference which measures visceral and subcutaneous fat in the abdominal region and hence total abdominal fatness. Waist circumference correlates well with intra-abdominal and subcutaneous fat measured by magnetic resonance imaging in young people, is also a central feature of the metabolic and a good tool for the screening of total body fat and the metabolic syndrome. Skinfold thickness measures subcutaneous fat at one or more sites to characterize total adiposity. The main cardiovascular risk indicators related with adipose tissue distribution are triglycerides, high-density lipoprotein cholesterol, insulin and blood pressure.

In this study, the effect of the consumption of diets rich in different sources of protein in cardiovascular risk indicators was measured. Consumption of lamb or chicken as part of a nutritionally balanced diet, did not have an effect on BMI, plasma total cholesterol, LDL-cholesterol, HDL-cholesterol and the sum of their 6 skinfold thicknesses in this sample of healthy young people. On the other hand, tryacilglycerol and insulin concentrations were reduced.

Our results support data from previously published studies suggesting that red meat (ruminant meat) and chicken could be interchangeable in a healthy and balanced diet as well as in a low-fat diet of hypercholesterolemic men and obese women.

The observed effect might be attributed partly to the presence of unsaturated fats in lamb, such as oleic acid and conjugated linoleic acid, suggested to promote cardiovascular health. Ruminant meat is a natural source of conjugated linoleic acid (CLA); lamb is the richest meat source of CLA. Small amounts of CLA (0.5% of the diet) have shown to alter the expression of genes and impact conditions such as carcinogenesis, obesity, diabetes and atherosclerosis in experimental animals; in addition, human supplementation studies suggested reduction of body weight and body fat following CLA supplementation for a short period of time. Therefore, CLA may be a healthy dietary component related to human health in the areas of cancer, obesity, diabetes and cardiovascular disease.

CLA and fatty acid composition of commercial lambs from different production systems (including Spain) were studied, as well as the influence of different cooking methods on CLA, fat content and fatty acid composition of edible lambs. Muscle of light lambs reared intensively was reported to have a higher concentration of unsaturated fatty acids compared to saturated acids (SFAs). Additionally omega-3 fatty acid concentrations were less affected by the cooking process compared to concentrations of omega-6 fatty acids. The proportion of fatty acids is affected by trimming the fat: lean meat is higher in polyunsaturated fatty acids (PUFA) and lower in SFAs than untrimmed meat. Lean meat is also a source of polyunsaturated fats, including omega-3 fatty acids, and pasture feeding contributes significantly to omega-3 fatty acid intakes in the diet. In contrast, meat from grain-fed animals does not provide omega-3 fatty acids but it is rich in omega-6 fatty acids (linoleic acid). In relation to the...
lipid composition in young and light lambs like Ternasco de Aragón, there are differences in the quantity and quality of the meat compared to other lambs, which are older and heavier or grass fed. Due to the age of slaughtering and feeding, Ternasco de Aragón has a higher unsaturated lipid profile, less fat percentage and less total cholesterol. Meat consumed from other types of lamb (from Anglo-Saxon bibliography) often comes from older and pasture-fed lambs. Pasture increases omega-3 fatty acids at intramuscular level; it produces a beneficial reduction of the n-6/n-3 ratio below the optimum of 4. But this is associated to older lambs, less energy density of the lamb diet, more general greased meat and more saturated fat than younger lambs like Ternasco de Aragón, especially if they are previously weaned.

Conclusion

The results of our study suggest that regular consumption of light lamb (Ternasco de Aragón) can form part of a healthy, varied and well-balanced diet. This is mainly due to observed changes in body composition and in cardiovascular disease risk indicators following a lamb-based diet. This study provides further evidence to support modification of established recommendations for health professionals, regarding the role of different types of meat to be consumed.

Acknowledgements

The authors wish to thank all participants for their collaboration recruited in three following centers: Residencia Juvenil “Luis Buñuel”, Instituto Aragonés de la Juventud, Departamento de Servicios Sociales y Familia of Teruel; Residencia Juvenil “Baltasar Gracián”, Instituto Aragonés de la Juventud, Departamento de Servicios Sociales y Familia of Zaragoza; and Residencia Internado “Santa Emerenciana”, Departamento de Educación of Teruel.

We sincerely thank the Servicio de Análisis Clínicos, Laboratorio de Bioquímica of the Hospital General “Obispo Polanco” of Teruel for their assistance with the blood analysis, and the Escuela Superior de Hostelería de Aragón of Teruel and the Instituto de Técnica y Tecnología Agroalimentaria (INTA) of Teruel for their collaboration, preparing the used recipes and the meat chemical analysis, respectively.

We gratefully acknowledge our colleagues of the GENUD Group, who helped to assess all measurements and questionnaires.

Funding

The study took place with the financial support of the INIA (Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria), INIA PET 2007-007-C08-03, and it was co-financed by the Fondo Europeo de Desarrollo Regional (FEDER).

References


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23. Campo MM, Reșconi V, Muela E, Oliván A, Sañudo C. Influence of cooking method on the fatty acid composition of edible lamb. 55Th ICoMST Congress; 2009 August 16-21; Copenhagen, Denmark.