Available online at www.sciencedirect.com
SCIENCE DIRECT®
Meat Science 70 (2005) 647–654
MEAT SCIENCE
www.elsevier.com/locate/meatsci

Nutritional profile of restructured beef steak with added walnuts

A. Serrano [a], S. Cofrades [a], C. Ruiz-Capillas [a], B. Olmedilla-Alonso [b], C. Herrero-Barbudo [b], F. Jiménez-Colmenero [a,*]

[a] *Instituto del Frio (CSIC), Ciudad Universitaria, 28040 Madrid, Spain*
[b] *Hospital Universitario Puerta de Hierro, San Martín de Porres 4, 28035 Madrid, Spain*

Received 1 January 2005; received in revised form 25 February 2005; accepted 25 February 2005

Abstract

Amino acid, fatty acid profile, cholesterol, vitamin E and mineral contents were assessed in restructured beef steak with 20% added walnut (20W). Compared with control restructured beef steak (0% added walnut), the product with added walnut presented a lower ($P < 0.05$) lysine/arginine ratio, larger ($P < 0.05$) quantities (mg/100 g product) of monounsaturated (MUFA) and *n*3 polyunsaturated (PUFA) fatty acids (mainly α-linolenic acid), a lower ($P < 0.05$) *n*6/*n*3 PUFA ratio and a higher ($P < 0.05$) polyunsaturated/saturated fatty acid ratio. The replacement of raw meat material by walnut reduced ($P < 0.05$) the cholesterol content and increased (more than 400 times) the amount of γ-tocopherol. Iron, calcium, magnesium and manganese contents of 20W sample were greater ($P < 0.05$) than in the control. Some changes induced by added walnut in the nutritional quality of the restructured product may present health benefits.

Keywords: Restructured beef steak; Walnut; Amino acids; Fatty acids; Cholesterol; Vitamin E; Minerals

1. Introduction

Nutrition is coming to the fore as a major modifiable determinant of non-communicable chronic diseases, with scientific evidence increasingly supporting the view that alterations in diet have strong effects, both positive and negative, on health throughout life (WHO, 2003). Optimal nutrition is focused to optimize the quality of the daily diet in terms of its content in nutrients and non-nutrients, and also other food properties that favour the maintenance of health. It is in this context that the so-called *functional foods* emerged and have come to represent one of the fastest growing segments of the world food industry.

Observational epidemiological studies show an inverse relationship between frequency of walnut consumption and risk of coronary heart disease (CHD) (Albert, Gaziano, Willett, & Manson, 2002; Fraser, Sabaté, Beeson, & Strahan, 1992). Walnuts, as part of a heart-healthy diet, reduce cholesterol concentrations in humans and animals (Feldman, 2002; Iwamoto et al., 2000; Sabaté, 1993). However, only in some intervention studies with randomized crossover dietary periods has this protective effect been observed as a result of the regular intake of walnuts (Iwamoto et al., 2000; Sabaté et al., 1993). The FDA recently authorized a qualified health claim indicating that eating 42.5 g per day of walnuts, as part of a low-saturated-fat and low-cholesterol diet and not resulting in increased caloric intake, may reduce the risk of CHD (FDA, 2004). This effect has been associated with the peculiar blend of nutrients and phytochemical compounds found in walnuts: high-biological-value proteins (low lysine/arginine ratio), vegetable fibre, monounsaturated (oleic) and polyunsaturated (linoleic and α-linolenic) fatty acids and micronutrients such as folic acid, magnesium, liposoluble

* Corresponding author. Fax: +34 91 5493627.
E-mail address: fjimenez@if.csic.es (F. Jiménez-Colmenero).

0309-1740/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.meatsci.2005.02.014

vitamins (especially γ-tocopherol) and other antioxidants (phytosterols and polyphenols).

Since not many people can be persuaded to consume walnuts in their pure state every day over a long period, it has been suggested that a good way to promote walnut intake would be to include walnuts in dishes prepared with nuts (Diehl, 2002), and to use them as an ingredient especially in frequently consumed foods. One such food is meat and meat derivatives, which constitute a very important component of the diet. Meat product processing makes it possible to introduce changes (replace, add or increase) in the amount and types of some components with potential functional effects. Modification of the ingredients used for the preparation of meat products has been tested in various ways with a view to enhancing health-beneficial components (Lee et al., 1998; Jiménez Colmenero, Carballo, & Cofrades, 2001; Kim, Godber, & Prinaywiwatkul, 2000). With strategies of this kind, restructured beef steaks with walnuts as an ingredient have been formulated resulting in products with acceptable physicochemical and sensory properties (Cofrades et al., 2004; Jiménez Colmenero et al., 2003).

These reformulated meat products could be considered potential functional foods in that they incorporate biologically active components that have the potential to produce functional effects. Since there have been no studies addressing the issue, the object of this paper is to analyse how the addition of walnut (20%) influences the nutritional profile (amino acids, fatty acids, cholesterol, vitamin E and mineral contents) of restructured beef steak.

2. Materials and methods

2.1. Preparation of products

Select beef top rounds (15 kg) were trimmed of visible fat and connective tissue and cut into strips (≈5 × 4 × 20 cm). Lots of approximately 1.2 kg were vacuum-packed, frozen and stored (−18 °C) until use.

For the preparation of restructured beef steak, meat packages were thawed (≈18 h 3 ± 2 °C, reaching between −3 and −5 °C) and passed once through a grinder (Mainca, Granollers, Spain) with a 2 cm plate. Two different restructured beef steaks (Table 1) containing 0% (control) and 20% (20W) added walnut (ground down to a particle size of <0.8 mm, supplied by Bernado Josa Quilez, Valencia. Spain) were prepared according to Cofrades et al. (2004). In the formulation of the 20W sample, the added walnut replaced an equal percentage of raw meat material. Restructured steaks (140 ± 3 g; 1.0 ± 0.05 cm thick) were frozen, packed individually in vacuum bags (Cryovac® BB4L, oxygen permeability 30 $cm^3\ m^{-2}\ 24\ h^{-1}$ at 23 °C, 0% RH and 1 bar) and stored at −20 °C until evaluation (within the first two weeks after production of the steaks). Portions, taken from at least two steaks (280 g) for each type of sample (control and 20W) were used for the following determinations.

2.2. Proximate analysis

Moisture and ash contents of the raw samples were determined in quadruplicate by AOAC (2000) methods 950.46 and 923.03, respectively. Fat content was evaluated in duplicate according to Bligh and Dyer (1959). Protein content was measured in quadruplicate according to AOAC (2000) method No. 992.15, by a Nitrogen Determinator LECO FP-2000 (Leco Corporation, St. Joseph, MI. USA).

2.3. Amino acid content

Sample amino acid content was determined by direct hydrolysis (in triplicate) in vacuum glass tubes at a ratio of 1:10 (w:v) with 6 N HCl and 2% phenol at 110 °C for 24 h. The amino acids were separated by means of cation-exchange chromatography, using a Biochron 20 automatic amino acid analyser (Amersham Pharmacia Biotech. Biocom, Uppsala, Sweden) with a high-resolution cation-exchange resin column Ultropac (9 ± 0.5 μm particle size, Pharmacia Biotech) 200 × 4.6 mm. The amino acids were determined and measured using ninhydrin derivative reagent at 570 nm. Proline was measured at 440 nm.

2.4. Fatty acid analysis

Lipids were extracted (in duplicate) as per Bligh and Dyer (1959). Esterification was performed according to UNE-EN ISO 5509, 2000. Fatty acids were determined as methyl esters (FAME) using a Perkin–Elmer gas chromatograph (Model 8500, Norwalk, Connecticut, USA) equipped with flame ionization detector (FID). Separations were carried out on a 60 m DB-63 (J&W, Agilent Technologies, USA) fused silica capillary column (0.25 mm i.d, 0.15 μm phase thickness). Operation parameters were: oven temperature 170 °C, injector temperature 250 °C and FID temperature 280 °C. Peaks

Table 1
Formulation of restructured beef steaks

Samples	Beef (g)	NaCl + STP[a] (g)	Walnut (g)	Water (g)	Total (g)
Control (0% added walnut)	3508	80 + 12	0	400	4000
20W (20% added walnut)	2708	80 + 12	800	400	4000

[a] STP-sodium tripolyphosphate.