Bulgarian Chemical Communications, Volume 46, Special issue B (pp.49 – 52) 2014

Healthy lipid combination. Effect of thermal processing on the quality characteristics of meat products

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Received August 20, 2014; Accepted Deember 25, 2014

The objective of this study was to investigate the effect of replacing animal fat in meatloaf with walnuts and various vegetable oils (sunflower, sea buckthorn and walnut). The chemical composition, cooking loss, lipid oxidation by thiobarbituric acid-reactive substances method (TBARs), total antioxidant capacity (TAC) of meatloaf was analysed. In the study the values of TBARs for meatloaf with walnuts and vegetable oils were lower than the control sample, revealing that the added materials acted like antioxidants. The sample containing walnuts and sea buckthorn oil had the highest TAC followed by the sample containing walnuts and sunflower oil. The incorporation of vegetable oils and walnuts successfully reduced the animal fat content in the final products while improving other characteristics.

Key words: walnuts, vegetable oils, cooking loss, meatloaf, antioxidant activity.

INTRODUCTION

Fat is an important constituent of processed meat products because it affects the stability of meat emulsions, reduces cooking losses, improves water holding capacity, provides flavor, texture, tenderness, juiciness, mouthfeel [1,2]. Fats have considerable effects on the binding, rheological and structural properties of meat products. Reducing the fat content in meat products and the substitution of animal fat with vegetable oils and walnuts should result in a healthier product [3]. The substitution of animal fat with vegetable oils has been suggested to improve the fatty acid profile and to decrease the cholesterol levels of meat products. Several vegetable oils have already been used as fat substitutes, such as olive, flaxseed, corn, soybean, and canola oil. It has been reported that walnuts, as part of a cardiohealth diet, may reduce the risk of coronary heart disease. This effect has been associated with the blend of nutrients and phytochemicals found in walnuts [4]. The objective of this study was to evaluate the replacing of animal fat with various vegetable oils and walnuts by studying proximate composition, cooking loss, lipid oxidation and total antioxidant capacity of meatloaf.

EXPERIMENTAL

Material

Fresh pork meat and pork back fat were obtained from a local processor at 48 h postmortem. Sea buckthorn oil was obtained from S.C. Hofigal Export Import S.A. Bucharest, Romania. Sunflower oil, walnut oil and all other additives (powder milk, sodium chloride and pepper) were purchased from a local supermarket in Galati (Romania). Walnuts (S.C. Romtransilvan S.R.L, Oradea, Romania) were ground down to a particle size of approximately 12 μm.

Method preparation.

Four different meatloaf formulations were prepared (Table 1). Control meatloaf (M) was made from fresh pork meat, pork back fat, sodium chloride and pepper, while LPFS, LPC and LPN samples contained walnuts, vegetable oil and powder milk.

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Table 1. Formulation (g) of experimental products.

Sample	Meat	Fat	Walnuts	Vegetable oil	Powder milk	Salt	Pepper	Water
M	450	150	-	-	-	3	2	45
LPFS	450	117	30	3	30	3	2	15
LPC	450	117	30	3	30	3	2	15
LPN	450	117	30	3	30	3	2	15

M – Control meatloaf, LPFS – meatloaf with walnuts and sunflower oil, LPC – meatloaf with walnuts and sea buckthorn oil, LPN – meatloaf with walnuts and walnut oil.

Table 2. Proximate composition, energy value and cooking loss of meatloaf containing various vegetable oils and walnuts.

Parameters	Meatloaf			
	M	LPFS	LPC	LPN
Moisture (g/100g)	51.79 ± 0.040	55.22 ± 0.022	52.43 ± 0.017	53.85 ± 0.015
Protein (g/100g)	19.68 ± 0.035	19.89 ± 0.031	20.83 ± 0.040	19.21 ± 0.031
Fat (g/100g)	29.28 ± 0.021	20.88 ± 0.025	20.01 ± 0.040	19.54 ± 0.023
Ash (g/100g)	0.89 ± 0.036	1.36 ± 0.025	1.32 ± 0.012	1.42 ± 0.017
Carbohydrate (g/100g)	-	2.66 ± 0.021	5.41 ± 0.006	5.87 ± 0.023
Energy value (kcal/100g)	342.25 ± 0.015	278.17 ± 0.017	285.07 ± 0.025	276.18 ± 0.021
Cooking loss (%)	13.06 ± 0.058	10.41 ± 0.015	11.93 ± 0.057	10.63 ± 0.032

All values are mean ± standard deviation.

Proximate analysis and cooking loss

The chemical compositions of meatloaf were determined using procedures prescribed by the official methods of analysis [5] for moisture, protein, fat and ash determinations. Carbohydrates were estimated by difference. Energy value was estimated from protein (× 4 kcal/g), carbohydrate (× 4 kcal/g) and fat (× 9 kcal/g) contents for each product. After cooking, the samples were cooled at room temperature for 30 min and the percentage of cooking loss was recorded as described by Franco and coworkers [6]. The analyses were made in triplicate.

Lipid oxidation and total antioxidant capacity

Oxidative stability of all samples was evaluated by measuring the formation of thiobarbituric acid-reactive substances (TBARs) following a modification of the method used by Serrano and coworkers [7]. The results were expressed as mg of malonaldehyde (MDA)/kg of meatloaf sample. Total antioxidant activity was determined based on the 6-hydroxy-2,5,7,8-tetramethyl-chroman-2-carboxylic acid (Trolox) equivalent antioxidant capacity (TEAC) assay developed by Miller and coworkers [8], and modified by Re and coworkers [9]. The results were expressed in μmol of Trolox/g of sample. Each sample was run in triplicate.

RESULTS AND DISCUSSION

Proximate analysis, energy values and cooking loss of meatloaf

The proximate composition, energy value and cooking loss of meatloaf samples are shown in Table 2. The moisture content was higher in the samples with vegetable oil and walnuts than the control because these samples were formulated with added walnuts which had higher water retention and improved emulsion stability. The highest moisture content was found in the sample LPFS. Similar trends in moisture content were observed when different amounts of vegetable oil and dietary fiber were added to meat emulsions Choi and coworkers [1]. The fat content was lower in the samples formulated with vegetable oil and walnuts (replacing pork fat) than the control (29.28 % fat) containing animal fat. The addition of walnuts and vegetable oils significantly raised the ash level of the meatloaf. Meatloaf had a carbohydrate content ranging from 2.66 to 5.87%, where the highest carbohydrate content was found in the sample with walnut oil and walnuts. The differences in energy value of meatloaf formulated with vegetable oils and walnuts were significant. The higher energy value was in the control (342.25 kcal/100 g) with animal fat compared to the other samples. The energy values of the meatloaf containing vegetable oil and walnuts ranged from 276.18 kcal/100 g (LPN) to 285.07 kcal/100 g (LPC). Cooking loss is affected by cooking method,

additives, the type of fat and the amount of fat in meat product. The effects of the replacement of pork back fat with vegetable oils and walnuts on the cooking loss of the meatloaf are shown in Table 2. The cooking loss was lower in meatloaf formulated with vegetable oils and walnuts than in the control sample. Some researchers Choi and coworkers [1] and Choi and coworkers [2] reported that cooking losses for low-fat meat emulsion systems were affected by the type of vegetable oil, dietary fiber used and reducing the animal fat content.

Effect of vegetable oils and walnuts addition on lipid oxidation and total antioxidant capacity of meatloaf

Results for TBARs index (mg MDA/kg of sample) are summarized in Figure 1. The determination of TBARs in samples with vegetable oils and walnuts showed a very low oxidation compared with control sample. TBARs ranged from 0.66 to 3.18 mg MDA/kg of sample. The highest TBARs value is for the control sample and might be due to high fat content in control meatloaf. The replacing of animal fat with vegetable oils and walnuts resulted in inhibition of the lipid oxidation in meatloaf.

TEAC of the samples determined by the ABTS•+ radical probes are presented in Figure 2 and expressed in μM Trolox/g of meatloaf. The total ABTS•+scavenging capacity of the meatloaf samples was in the range 16.26 ± 0.03 μM Trolox/g for control sample to 22.65 ± 0.015 μM Trolox/g for LPC.

Comparing the ABTS•+ results of the meatloaf samples, the TEAC of the samples with vegetable oils and walnuts were significantly higher than the control sample. Different components from vegetable oils and walnuts are responsible of this TEAC.

CONCLUSIONS

Commercially available vegetable oils, such as sunflower, walnut and sea buckthorn oils and walnuts were successfully used as substitutes for pork back fat in the production of meatloaf. Reduced-fat meatloaf would be beneficial for health since they have lower total fat and energy. The addition of various vegetable oils and walnuts can contribute to the development of meatloaf with desirable quality characteristics.

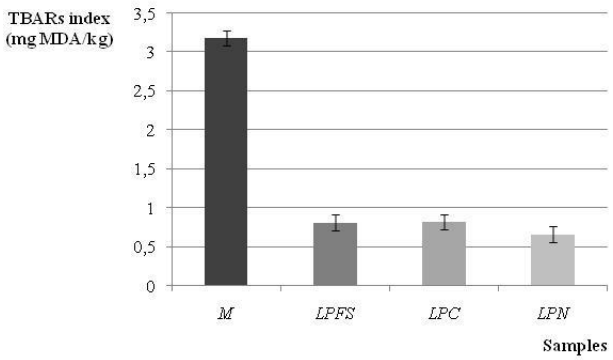

Figure 1. Effect of vegetable oils and walnuts on lipid oxidation of meatloaf.

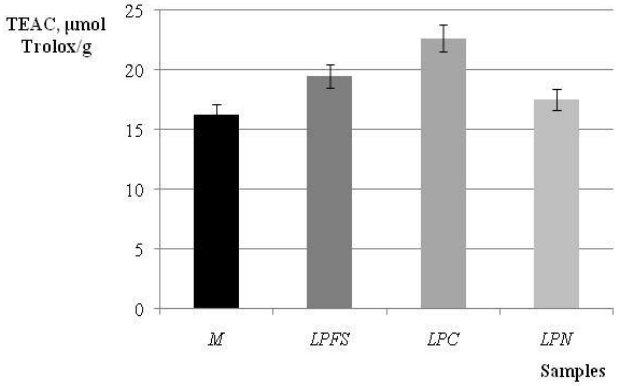

Figure 2. TEAC of meatloaf determined using ABTS as antioxidant probes.

Acknowledgements. *The work of Gabriel–Dănuţ MOCANU has been funded by the Sectoral Operational Programme Human Resources Development 2007-2013 of the Ministry of European Funds through the Financial Agreement POSDRU/159/1.5/S/132397.*

The research is financed by CNCSIS-UEFICDI Romania as National Project II no. 115/2012 – OPTIMEAT.

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КОМБИНАЦИЯ НА ЗДРАВОСЛОВНИ ЛИПИДИ. ВЛИЯНИЕ НА ТЕРМИЧНАТА ОБРАБОТКА ВЪРХУ КАЧЕСТВЕНИТЕ ХАРАКТЕРИСТИКИ НА МЕСНИ ПРОДУКТИ

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Постъпила на 20 август, 2014 г.; приета на 25 декември, 2014 г.

(Резюме)

Целта на настоящото проучване беше да се изследва ефекта на заместване на животинската мазнина в руло „Стефани" с орехи и различни растителни мазнини (слънчогледова, орехова и от морски зърнастец). Изследвани са химичния състав, загубите при готвене, липидното окисление по метода на реакцията с тиобарбитурова киселина, общия антиокидантен капацитет (ОАК). Беше установено, че за руло „Стефани" с орехи и различни растителни мазнини продуктите от реакцията с тиобарбитурова киселина са по-малко в сравнение с контролата, което разкрива възможността на добавените материали да действат като антиоксиданти. Образците, мазнина от орехи и морски зърнастец, притежават най-висок ОАК, последвани от образците, съдържащи орехи или слънчогледово масло. Включването на растителни масла и орехи успешно намалява съдържанието на животинска мазнина в крайния продукт, като подобрява техните характеристики.