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Influence of deep fat frying on some nutritional parameters of novel food based on mushrooms and fresh soft cheese

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Abstract

The aim of this work was to evaluate the influence of deep fat-frying on some nutritional parameters of three novel preliminarily frozen (−20 °C/30 days) deep fat-fried products based on mushrooms (*Agaricus bisporus*) and fresh soft cheese. Chemical composition before and after deep fat-frying were determined by standard AOAC methods. Protein digestibility (D) of deep fat-fried products was examined by an in vivo test and consumer preference of tested products was established by nine-point hedonic scale. The results of this investigation showed a statistically significant difference in chemical composition (macro-nutrients and energy value) between fresh and preliminarily frozen and deep fat-fried products. Protein digestibility (D) values in preliminarily frozen deep fat-fried products were higher than reported data for fresh mushrooms and lower than reported data for cheese. Results of the nine-point hedonic scale showed high values of consumer preference for tested products. Deep fat-frying increases fat and energy contents of tested food. All tested products after deep fat-frying still had high percentages of preference.

Keywords: Mushrooms; Soft cheese products; Deep fat fry; Protein digestibility

1. Introduction

Human nutrition has become more complicated since the outbreak of diseases connected with animal meat. The human race has a growing need for proteins, so there is a reason for investigations of natural, especially vegetable and unconventional products, created as nutritional substitutes for traditional fast food.

Champignons (*Agaricus bisporus*) are the most consumed mushrooms, and fresh soft cheese is the base of some very tasteful and nutritionally well-balanced products. Mushrooms have also been reported as therapeutic foods, useful in preventing diseases such as hypertension, hyperchoesterolemia and cancer (Bobek & Galbavy, 1999; Bobek, Ozdyn, & Kuniak, 1995). Freezing and deep fat-frying are the most common ways of preserving and preparing fast food.

During deep fat-frying, a complex series of reactions takes place, resulting in hydrolysis, oxidation and polymerization of the oil, and the quality of the fried foods is affected by that of the oil (Dobarganes & Marquez-Ruiz, 1998).

Literary data are mainly focussed on nutritive value of mushrooms and cheese in the fresh state (FAO, 1970; Longvah & Deosthale, 1998). The aim of this work is to establish the nutritive value of preliminarily frozen deep fat-fried mushrooms, cultivated champignons, and some fresh soft cheese-based products.

2. Materials and methods

The following products were analysed:

1. fresh champignons (*Agaricus bisporus*) and deep fat-fried, preliminarily frozen champignons;
2. "product I", based on fresh soft cheese (cheese: grits:eggs = 18:3:1) in the fresh state and "product I", preliminarily frozen and deep fat-fried; and
3. "product II", based on fresh soft cheese (cheese: grits:eggs:spinach = 17:3:1:1) and "product II", preliminarily frozen and deep fat-fried.

Mushrooms and "product I" and "product II", after analysing in the fresh state, were frozen for 30 days at

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−20 °C and deep fat-fried in sunflower seed oil (10 min at 150 °C).

Chemical composition (proteins, fat, carbohydrates, water, ash) of all fresh and deep fat-fried products, as testing proteins, and eggs, as control protein, were determined according to AOAC (1995).

The methodology of protein quality evaluation of all three products was based on biological methods in vivo—feeding young growing rats as proportion of food nitrogen that is absorbed (AOAC, 1995). The control protein was dried whole egg.

The Wistar rats (Institute of Medical Research, Zagreb, Croatia), 3 weeks of age, were maintained on stock pellets for 7 days in an air-conditioned room at a temperature of 23±1 °C. All rats received water and food ad libitum. After the adaptation period, animals were divided into five groups with five rats in five separate cages. Three groups were fed with testing protein diets, based on preliminarily frozen and deep fat-fried mushrooms, and "product I" and "product II". The fourth and fifth groups were control groups. One was fed a diet of dried eggs and the other a non-protein diet. During the test period the consumed foods were measured, and faeces were collected and analysed for nitrogen by the micro-Kjeldahl method (AOAC, 1995).

From these results protein digestibilities (D) were calculated with calculations reported by Miller and Bender (1955).

For determination of product acceptability, a nine-point hedonic scale, as sensory evaluation technique, was used. The method was described by Meilgaard, Civille, and Carr (1991).

Table 1
Chemical composition and energetic values of fresh mushrooms, and fresh products based on soft cheese ($n=3$)

Parameter	Mushrooms		Product I		Product II	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Proteins (% dw)	41.0	0.12	25.7	0.11	23.3	0.10
Fats (% dw)	4.76	0.02	13.3	0.07	7.26	0.04
Ash (% dw)	12.72	0.06	5.27	0.01	4.75	0.01
Carbohydrates (% dw)	41.5	0.14	55.2	0.31	65.6	0.33
Energetic value (kJ/100 g)	132	0.25	835	0.28	731	0.24
Proteins (% kJ)	44.0	0.14	23.1	0.10	22.2	0.10
Fats (% kJ)	11.5	0.03	26.9	0.09	15.5	0.08
Carbohydrates (% kJ)	44.6	0.16	50.0	0.24	62.3	0.25

Table 2
Chemical composition and energetic values of preliminarily frozen deep fat-fried mushrooms and preliminarily frozen deep fat-fried products based on soft cheese ($n=3$)

Parameter	Mushrooms		Product I		Product II	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Proteins (% dw)	30.6	0.02	22.5	0.10	17.7	0.08
Fats (% dw)	18.0	0.12	26.8	0.11	15.5	0.06
Carbohydrates (% dw)	43.17	0.14	49.81	0.28	61.91	0.24
Ash (% dw)	8.18	0.06	0.59	0.01	3.36	0.01
Energetic value (kJ/100 g)	1635	0.25	1283	0.30	1103	0.25
Proteins (% kJ)	28.7	0.15	16.6	0.08	16.9	0.07
Fats (% kJ)	38.0	0.08	30.0	0.12	45.5	0.18
Carbohydrates (% kJ)	33.4	0.16	53.4	0.24	37.6	0.16

3. Results and discussion

Protein, carbohydrate and ash content of mushrooms are significantly affected by the technological process (Manzi, Aguzzi, & Pizzoferrato, 2001), but proximate composition also depends on the species (Manzi, Gambelli, Marconi, Vivanti, & Pizzoferrato, 1999).

The results of chemical composition and energetic value of fresh mushrooms and of fresh soft cheese-based products are shown in Table 1. Mushrooms were almost twice as good a protein source as products based on soft cheese, while those two were better source of carbohydrates. The crude protein content of the common mushroom (*A. bisporus*) has been reported to be 19–38% on a dry weight basis (Braaksma & Schaap, 1996). Except for the egg powder, the proportion of fats was 4.76–13.33% (dw). The energetic values of fresh products based on fresh soft cheese were (731– 825 kJ/100 g), but mushrooms were only 132 kJ/100 g.

Table 2 shows chemical composition and energetic values of deep fat-fried preliminarily frozen mushrooms and soft cheese products.

After the deep fat-frying mushrooms and products I and II had higher amounts of fat (15.46–26.81% dw) and energy values (1103–1635 kJ/100 g). Energies of fat fractions were also 2–3 times higher in fried than in raw products which is also a reason for their higher energy value.

Table 3
Energetic value and energetic proportion due to proteins, fats and carbohydrates in 100 g of testing diets and control diets by rat bioassay ($n=3$)

Products	Energetic value (kJ)	Energetic proportion (%)		
		Proteins	Fats	Carbohydrates
Testing diets				
Diet 1 (mushrooms)	1527	11.0	14.5	74.5
Diet 2 (product I)	1206	8.26	28.1	63.7
Diet 3 (product II)	1352	6.13	21.4	72.5
Control diets				
Dried egg	1742	11.3	25.5	63.2
Non-protein	1616	0	11.90	88.10

Table 4
Measured parameters during and after testing period for different protein sources

Parameter	Diet 1 Mushrooms		Diet 2 Product I		Diet 3 Product II		Control diet (eggs)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Intake N/day (mg)	478	0.12	971.3	0.14	1031	0.11	871	0.11
Faecal N (g)	1.19	0.01	1.31	0.02	1.54	0.01	1.17	0.01
D (protein digestibility)	79.7	0.07	92.8	0.03	91.0	0.07	93.9	0.05

Table 5
Results of "hedonic scale" for tested deep fat-fried products

Product	Standard deviation	% of dislike	% of preference	Mean
Mushrooms	1.22	2.40	97.6	7.41
Product I	0.816	0	100	7.25
Product II	1.50	0.187	99.8	5.88

Energetic values and energetic proportions due to protein, fat and carbohydrate, in three testing and one control diet, are shown in Table 3. Each of three testing diets was based on one protein source (deep fat-fried preliminarily frozen mushrooms, or deep fat-fried preliminarily frozen "product I" and deep fat-fried preliminarily frozen "product II"). Energy values of test diets were 1200–1550 kJ, while the control protein diet (dried egg) was richer in energy.

Calculations and measuring parameters during the testing period are presented in Table 4. Protein digestibility (D) shows the proportion of food nitrogen that is absorbed. Results are compared with egg protein digestibility as control and reference protein (FAO, 1970).

Results of this bioassay show that both preliminarily frozen and deep fat-fried products based on soft cheese (product I and product II) had high digestibility (D). Detected digestibility of mushroom protein, was as expected, lower. The vegetable proteins always have lower digestibility then animal proteins because of more difficult accessibility to proteolytic enzymes.

Longvah and Deosthale (1998) discussed true digestibility of edible wild mushrooms, *Schiziphyllum comune* and *Lentinus edodes*, which were 53.2 ± 10.2 and 76.3 ± 5.4, respectively.

Literary reports (FAO, 1970) indicate higher values of protein digestibility for fresh cheese (98.8%), but the tested products consisted of mixtures of cheese, grits, spinach and eggs, so probably the vegetable proteins decrease protein digestibility of these products.

A group of consumers, using the "hedonic scale" as a sensory evaluation technique also tested deep fat-fried products. The hedonic scale is an evaluation technique that can be used to optimize product acceptability. The results of the hedonic scale are shown in Table 5. All three tested products had high percentages of preference (97.6–100%). The highest mean value was mushrooms, and the lowest product II.

This research shows that deep fat-frying, to which these foods could be submitted in fast food cooking procedures, harms the nutritional quality of these products. Fresh mushrooms and cheese (by literature reports) prove to be excellent foods that can be used in well-balanced diets. Deep fat-frying increases fat and energy content of food. Protein digestibility, of deep fat-fried mushrooms, is, as expected, higher than fresh mushrooms. Products based on fresh cheese had lower digestibilities than cheese mixtures due to being mixed with some vegetable proteins. All tested products, after deep fat-frying, still had high percentages of preference.

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