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Assessment of the Nutritive Value of Dishes Designed for Athletes – Grilled Chicken Salad and Spaghetti with Tomatoes and Parmesan Cheese

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The research was stimulated by the lack of data on the nutritional value of several dishes preferred by athletes. The aim of this study was to determine the nutritional value of selected designed dishes, grilled chicken salad and spaghetti with tomatoes and parmesan.

The examined material was analysed for contents of protein, fat, fibre, and dry matter according to respective standards. Energetic value was calculated using Atwater factors.

The energy value of spaghetti with tomatoes and parmesan cheese amounted to 81.1 kcal/100 g and was statistically significantly higher ($P<0.001$) than that of the grilled chicken salad (67.0 kcal/100 g of product), which was associated with a significantly higher content of total carbohydrates (15.54 *vs*. 2.77 g/100 g), and significantly lower contents of protein (3.83 *vs*. 7.25 g/100 g) and fat (1.33 *vs*. 4.04 g/100g). The content of dietary fibre in examined dishes was similar, and amounted to 2.32 g/100 g and 2.33 g/100 g in the spaghetti and salad, respectively ($P<0.001$). The ratio of saturated to monounsaturated and polyunsaturated acids per 100 g of the chicken salad and spaghetti with tomatoes and parmesan cheese was 0.68:2.98:0.38 g and 0.54:0.61:0.18 g, respectively.

High contents of protein in grilled chicken salad and digestible carbohydrates in spaghetti with tomatoes and parmesan, as well as favourable fatty acid profile substantiates their use as part of the balanced diet for sportspersons.

INTRODUCTION

The diet of individuals who participate in sports plays an important role in maintaining health and optimizing the effects of training. Due to the intense metabolic processes and oxidative stress, athletes need additional energy, carbohydrates, proteins, as well as specific vitamins and minerals in order to balance their nutritional requirements [Campbell *et al.*, 2007; Manore & Thompson, 2006; Maughan *et al*., 2004; Sadowska-Krępa & Kłapcińska, 2005; Rodriguez *et al*., 2009]. Still, the results of numerous Polish and foreign studies indicate that the diets of athletes are not free from nutritional mistakes and deficiencies, which are associated with an insufficient consumption of some groups of food products, including wholegrain cereals, dairy products, vegetables, fruits, and fish, leading to the lack of balanced supply of various nutrients [Czaja *et al*., 2008; Czeczelewski *et al.,* 2011; Farajian *et al.,* 2004; Frączek, 2007; Gacek, 2011; Machefer *et al.,* 2007; Nowacka *et al.,* 2010; Tukhtarov, 2010; Ubeda *et al.,* 2010]. An increase in the demand for proteins and carbohydrates depends on the character of a sports discipline, with proteins playing a particular role in the weight (strength) training and high-speed, and carbohydrates – in the endurance training [Manore & Thompson, 2006; Campbell *et al*., 2007; Maughan *et al*., 2004; Phillips, 2004; Tarnopolsky, 2004]. Studies of athletes' dietary preferences have confirmed a high preference for some groups of products, including white meat and pasta [Iglesias-Gutierrez *et al.,* 2008; Ubeda *et al*., 2010], which is consistent with authors' previous observations.

Our research was stimulated by the lack of data on the nutritional value of several dishes preffered by athletes, that are characterised by a low or moderate glycaemic index and are sources of carbohydrates, protein, vitamins, and minerals. The aim of this study was to determine the nutritional value of selected designed dishes, grilled chicken salad and spaghetti with tomatoes and parmesan, which may be important elements of dietary servings for athletes.

MATERIALS AND METHODS

Materials

Analytical assessment of nutritional values was carried out in regards to the two designed dishes: grilled chicken salad, and spaghetti with tomatoes and parmesan cheese. The dishes were prepared based on the following recipes, expressed as an amount of market-available products required for the preparation of 100 g of ready-to-eat dish. Preparation of 100 g of chicken salad required: raw tomatoes (14.8 g), red

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peppers (14.8 g), red onions (7.4 g), raw cucumber (14.8 g), iceberg lettuce (17.8 g), chicken fillet (28 g), along with an egg yolk (0.6 g), mustard (1.4 g), olive oil (3.4 g), mineral water (3.4 g), and lemon juice (0.07 g) used as a components of the salad dressing. Preparation of 100 g of spaghetti with tomatoes required: egg-free noodles (14 g), white onions (9.3 g), red onions (9.3 g), raw tomatoes (28 g), red peppers (8.4 g), garlic (1.4 g), canned tomatoes (37.3 g), raw mushrooms (14 g), olive oil (0.5 g), and low-fat parmesan cheese (1.9 g). Each dish was prepared three times, and three samples from every meal were analysed, which corresponded to nine measurements of the nutritional value.

Biochemical analyses

Biochemical analyses were carried out at the Małopolska Center of Food Monitoring and Attestation (MCMiAŻ) at the Agricultural University in Cracow between November 15th, 2010 and January 29th, 2011. All methods have been validated in MCMiAŻ, using quality control (CRM NCS ZC 73012).

The content of protein in the examined material was determined based on its nitrogen content, multiplied by the respective coefficient (6.25). The nitrogen content was measured using Dumas' method with Truspec N (LECO, USA) analyser and in accordance with MCMiAŻ/PB-02 examination procedure. Fat content was determined in accordance with the Polish Standard PN-A-82100:1985 (Soxhlet System HT2 1045 Extraction Unit, Tecator, Höganäs, Sweden). The samples were treated with hydrochloric acid to hydrolyse the protein and carbohydrate and fat complexes, and then fat separated from the hydrolysate was determined by extraction with organic solvent. Fatty acid profile was analysed by means of gas chromatography with a Varian 3400 analyser [Bou *et al*, 2005]. The content of fibre was determined according to AOAC 991.43 method, and determination of dry mass content was performed according to PN-85/A-82100 standard. Samples were mixed with sand and ethanol and dried in a water bath, then in a drier at 105°C (Venticell, BMT as, Brno, Czech Republic). Total carbohydrate content was calculated from the following formula: 100 – (water + ash + protein + fat). The amount of digestible carbohydrates was determined as the difference between total carbohydrate and dietary fibre contents. The energetic value of the examined material was calculated using Atwater factors that corresponded to 37 kJ/g for fat and 17 kJ/g for protein and carbohydrates [Kunachowicz *et al.,* 2005].

Statistical analysis

The results were presented as mean and standard deviation ($\bar{X} \pm SD$). A statistical analysis of data was conducted with the Student's test using Excel 2007 at a significance level of $P<0.001$.

RESULTS AND DISCUSSION

The energy value and contents of basic nutrients expressed per 100 g of product in the examined dishes are presented in Table 1. This data shows that spaghetti with tomatoes is characterised by statistically significantly higher average contents of dry matter and ash as compared to the chicken salad (21.99 *vs*. 14.79 g/100 g, and 1.29 *vs*. 0.72 g/100 g of the product, respectively). The energy value of spaghetti with tomatoes (81.1 kcal/100 g) was statistically significantly higher compared to the chicken salad (67.0 kcal/100 g of product) ($P<0.001$). The higher energy value of spaghetti was associated with a higher content of total carbohydrates (15.54 *vs*. 2.77 g/100 g), and lower contents of protein (3.83 *vs*. 7.25 g/100 g) and fat (1.33 *vs*. 4.04 g/100 g) ($P<0.001$). The content of dietary fibre in the examined dishes was similar, and amounted to 2.32 g/100 g and 2.33 g/100 g in the spaghetti and chicken salad, respectively.

TABLE 1. Energy value and content of basic nutrients in the analysed dishes (per 100 g of product).

Nutrients		Grilled chicken salad ($\bar{X}\pm SD$)	Spaghetti with tomatoes and parmesan ($\bar{X}\pm SD$)
Energy value (kcal)		67.0±2.34	81.1±0.19***
(kJ)		280.5±9.81	339.2±0.82***
Dry matter (g)		14.79±0.06	21.99±0.09***
Ash (g)		0.72±0.01	1.29±0.007***
Total protein (g)		7.25±0.04	3.83±0.02***
Total fat (g)		4.04±0.03	1.33±0.02***
Fatty acids (g)	Saturated	0.684±0.002	0.544±0.001***
	Monounsaturated	2.976±0.002	0.606±0.0009***
	Polyunsaturated	0.376±0.0005	0.179±0.0001***
Total carbohydrates (g)		2.77±0.28	15.54±0.06***
Digestible carbohydrates (g)		0.44±0.23	13.22±0.04***
Dietary fibre (g)		2.33±0.12	2.32±0.23 (NS)

*** The differences between the dishes statistically significant at $P<0.001$. NS – no statistical differences ($P>0.05$). SD- standard deviation, $\bar{X}$ – mean.

Examination of nutritional values of selected cereal products [Ranhotra *et al.*, 1984] revealed that the protein content of cooked pasta amounted to 4.4–5.3%. According to other studies, the chemical composition of extruded pasta includes a protein content of 10.0–11%, and ash and dietary fibre contents of 0.4–1.8% and 4.0–4.5%, respectively [Sobota & Skwira, 2009]. As indicated by the tables of contents and nutritional value, published by the United States Department of Agriculture (USDA) [Gebhardt & Thomas, 2002], spaghetti Bolognese (with meat sauce) contains 78% of water, whereas the content of water in spaghetti with tomato sauce and cheese amounts to 80%, and is, therefore, similar to the value determined in our study. The energy value of spaghetti with tomato sauce determined in the American study [Gebhardt & Thomas, 2002] was similar to that of our study (76.19 kcal/100 g), while the energy value of spaghetti with meat sauce was higher (90.11 kcal/100 g). It seems that the protein content of this dish, as established in our study, places it between the values determined for spaghetti Bolognese (4.95 g/100 g) and spaghetti with tomato sauce and cheese (2.38 g/100 g) by Gebhardt & Thomas [2002]. The content of fat measured in spaghetti with tomatoes prepared in our study was slightly higher than that of the Ameri-

TABLE 2. Saturated fatty acid (SFA) profile in the fat extracted from the analysed dishes (%).

Fatty acids	Grilled chicken salad ($\bar{X}$±SD)	Spaghetti with tomatoes and parmesan ($\bar{X}$±SD)
C-10:0	0.015±0.003	1.721±0.091***
C-12:0	0.112±0.01	2.070±0.077***
C-14:0	0.162±0.009	6.464±0.196***
C-15:0	0.02±0.001	0.659±0.011***
C-16:0	13.10±0.381	23.334±0.185***
C-17:0	0.082±0.001	0.335±0.007***
C-18:0	2.977±0.065	5.906±0.191***
C-20:0	0.32±0.013	0.250±0.003***
C-22:0	0.094±0.007	0.086±0.005 (NS)
C-24:0	0.046±0.003	0.068±0.002***
Sum FAS	16.933±0.049	40.898±0.077***

*** The differences between the dishes statistically significant at P<0.001. NS – no statistical differences (P>0.05). SD- standard deviation, $\bar{X}$ – mean.

can study (0.79 and 1.06 g/100 g), while the carbohydrate contents were similar (15.19 *vs*. 15.47 g/100 g). The average content of dietary fibre in our spaghetti with tomatoes fits in between the values of spaghetti Bolognese (1.8 g/100 g) and spaghetti with tomato sauce analysed in the American study (3.09 g/100 g). According to the results of the same American study, chicken with vegetables contains 83% of water (slightly less that our chicken salad), and the nutritional value of 100 g of the product includes 69.17 kcal, 5 g of protein, 2.08 g of fat, and 7.92 g of carbohydrates [Gebhardt & Thomas, 2002]. Chicken with vegetables, as compared to the chicken salad analysed in our study, is characterised by a similar energy value, lower contents of protein and fat and a higher carbohydrate content.

The profile of fatty acids in the extracted fat of the analysed dishes is presented in Tables 2–4. Both dishes showed a predominance of monounsaturated fatty acids, which amounted to 73.7% of the total fatty acids in chicken salad, and 45.6% of fatty acid pool in spaghetti with tomatoes,

TABLE 3. Monounsaturated fatty acid (MUFA) profile in the fat extracted from the analysed dishes (%).

Fatty acids	Grilled chicken salad ($\bar{X}$±SD)	Spaghetti with tomatoes and parmesan ($\bar{X}$±SD)
C-14:1	0.032±0.003	0.514±0.022***
C-16:1 (n9)	0.202±0.006	0.249±0.002***
C-16:1 (n7)	1.069±0.044	1.363±0.009***
C-17:1	0.122±0.001	0.205±0.006***
C-18:1 (n9)	68.8±0.241	41.263±0.535***
C-18:1 (n7)	2.652±0.098	1.737±0.033***
C-20:1 (n9)	0.386±0.014	0.187±0.003***
C-22:1	0.377±0.025	0.061±0.008***
C-24:1 (n9)	0.026±0.002	0.012±0.002***
Sum MUFA	73.667±0.048	45.595±0.068***

*** The differences between the dishes statistically significant at P<0.001. SD – standard deviation, $\bar{X}$ – mean.

and corresponded to 2.98 g and 0.61 g per 100 g of product, respectively (P<0.001) (Table 1). Oleic acid (C-18:1) clearly predominated and amounted to 68.8% and 41.3% of the total pool of fatty acids in the chicken salad and spaghetti with tomatoes, respectively; these figures corresponded to 2.78 g and 0.55 g per 100 g of product, respectively (P<0.001). The ratio of saturated to monounsaturated and polyunsaturated acids per 100 g of the chicken salad and spaghetti with tomatoes was 0.68:2.98:0.38 g and 0.54:0.61:0.18 g, respectively. In contrast, the lipid profile analysis of spaghetti with tomato sauce and cheese presented in the USDA report suggests the predominance of saturated fatty acids, as confirmed by 0.32:0.12:0.12 g ratio of saturated to monounsaturated to polyunsaturated fatty acids in 100 g of the product. The fractions of individual fatty acids groups in spaghetti Bolognese were quite similar (0.35:0.32:0.32 g/ 100 g of the product). Chicken with vegetables, another dish presented in the USDA report, was characterised by the predominance of monounsaturated acids in the fatty acid profile, similarly to the chicken salad that was analysed in our study; the ratio of various fatty acid groups in 100 g of chicken with vegetables amounted to 0.58:0.92:0.42 g [Gebhardt & Thomas, 2002].

The share of the analysed products (100 g) in covering for recommended dietary allowances (RDA) for energy and basic nutrients in young and physically-active individuals [Jarosz & Bułhak-Jachymczyk, 2009] is presented in Table 5. High degree of physiological requirement coverage was documented in the case of protein contained in the chicken salad (11.51% of RDA and 13.43% of RDA for men and women, respectively), and digestible carbohydrates in spaghetti (10.17% of RDA according to the needs of the brain, irrespective of gender), as well as dietary fibre in both analysed dishes (from 5.80% up to 11.65% of the norm). However, a comparison of protein content in 100 g of chicken salad to the higher protein requirement of sportspersons (from 1.2–1.4 g/kg in endur-

TABLE 4. Polyunsaturated fatty acid (PUFA) profile in the fat extracted from the analysed dishes (%).

Fatty acids	Grilled chicken salad ($\bar{X}$±SD)	Spaghetti with tomatoes and parmesan ($\bar{X}$±SD)
C-18:2 (n6)	7.974±0.076	10.576±0.044***
C-18:3 (n6)	0.0163±0.001	0.045±0.003***
C-18:3 (n3)	1.0186±0.032	1.237±0.022***
C-20:2 (n6)	0.0306±0.002	0.023±0.002***
C-20:3 (n6)	0.031±0.004	0.046±0.005***
C-20:4 (n6)	0.123±0.004	0.048±0.002***
C-20:5 (n3)	0.012±0.001	0.068±0.004***
C-22:4 (n6)	0.029±0.002	0.016±0.003***
C-22:5 (n3)	0.028±0.004	0.031±0.004 (NS)
C-22:6 (n3)	0.051±0.006	0.017±0.003***
Sum PUFA	9.314±0.013	13.474±0.009***
Sum n3 PUFA	1.109±0.011	1.354±0.008***
Sum n6 PUFA	8.204±0.014	10.756±0.009***

*** The differences between the dishes statistically significant at P<0.001. NS – no statistical differences (P>0.05). SD – standard deviation, $\bar{X}$ – mean.

TABLE 5. The level of coverage for recommended dietary allowances (RDA) for energy and basic nutrients per 100 g of product for young women (60 kg) and men (70 kg) between 19 and 30 years of age characterised by a high level of physical activity (PAL 2.2) [Jarosz & Bułhak-Jachymczyk, 2009].

Components	RDA standard		% RDA	
			Grilled chicken salad ($\bar{X}$±SD)	Spaghetti with tomatoes and parmesan ($\bar{X}$±SD)
Energy	Men	3850 kcal	1.7±0.06	2.1±0.05***
	Women	3050 kcal	2.2±0.08	2.7±0.001***
Protein	Men	63 g (0.9 g/kg)	11.51±0.06	6.08±0.03***
	Women	54 g (0.9 g/kg)	13.43±0.07	7.09±0.04***
Fat	Men	107 – 128 g	3.77±0.03 – 3.16±0.02	1.24±0.02 – 1.04±0.01***
	Women	85–102 g	4.75±0.03 – 3.96±0.03	1.56±0.02 – 1.30±0.02***
Digestible carbohydrates	Men and women	130 g	0.34±0.21	10.17±0.35***
	Men	45–65% of energy	0.10±0.05 – 0.07±0.04	3.05±0.009 – 2.11±0.006***
	Women	45–65% of energy	0.13±0.07 – 0.09±0.05	3.85±0.01 – 2.67±0.008***
Dietary fibre	Men and women	20–40 g	11.65±0.6 – 5.82±0.3	11.60±1.15 – 5.80±0.57 (NS)

*** The differences between the dishes statistically significant at $P<0.001$. NS – no statistical differences ($P>0.05$). SD – standard deviation, $\bar{X}$ – mean.

ance disciplines, 1.5–1.7 g/kg in speed-endurance disciplines, and up to 2 g/kg in typical strength disciplines) [Phillips, 2004; Tarnopolsky, 2004; Campbell *et al.,* 2007; Rodriguez *et al.,* 2009], reduced the degree of discipline-specific coverage of the physiological requirement for protein from 8.63–7.39%, *via* 6.90–6.09%, to 5.18% in men, and from 10.07–8,63%, *via* 8.05–7.11%, to 6.04% in women, respectively. However accepting the demand for carbohydrates at the level of 45–65% of the total energy, the digestible carbohydrates included in 100 g of proposed spaghetti with tomatoes are determining the completion of the daily demand in the range from 3.85% up to 2.67% in women and from 3.05% up to 2.11% in men, at the adopted recommendations for energy and body weight.

The degrees of RDA coverage and high nutrient density of the analysed dishes, particularly in regard to protein content in chicken salad and spaghetti with tomatoes, carbohydrate content of the spaghetti, and dietary fibre content of both (INQ>1), suggest their high usability in rational planning of balanced nutritional servings also for individuals who undertake intensive physical activity. Generally, athletes' diets require an increased supply of nutrients and energy, *i.e.* carbohydrates and protein of high biological value. Furthermore, the nutritional value of the analysed dishes, particularly chicken salad, is confirmed by the presence of raw vegetables, which hold a high position in the content-based nutrient model of food categorization (nutrient profiling of food) [Drewnowski & Fulgoni, 2008]. Vegetables and raw vegetables are nutrient-rich foods (NRFs) as confirmed by their 45th and 70th rank in the logarithmic scale of nutritional density that ranges between 1 and 100 [Drewnowski & Fulgoni, 2008; Drewnowski, 2009]. Moreover, the high nutritional value of the dishes prepared in our study was validated by the analysis of nutrient profile models (NPMs), indicating that the models based on protein, fibre, vitamins and minerals correlate positively with nutrient density and inversely with energy density of food [Drewnowski, 2007; 2009; Drewnowski *et al*., 2009]. The content of protein and fibre per 100 g of chicken salad amounted to 10.81 g and 3.47 g, respectively; and in spaghetti with tomatoes to 4.72 g and 2.86 g, respectively. A comparison of nutritional density indices of the analysed dishes, expressed as the sum of protein and fibre content per 100 kcal of the product, with the values revealed by the nutrient profile model analysis proposed by Drewnowski *et al.* [2009], places the chicken salad (14.28% /100 kcal) among the products with high nutrient density and spaghetti with tomatoes (7.58% /100 kcal) among those with moderate nutrient density. Furthermore, the health benefits of the analysed dishes include their favourable profiles of fatty acids, *i.e.* the predominance of monounsaturated fatty acids and, in particular, the oleic acid, which is considered to be one of the pillars of the Mediterranean diet recommended in the prevention of degenerative disorders [Gillingham *et al.,* 2011]. Including these products into the planned nutritional servings for physically-active individuals is highly advisable, particularly in view of the fact that according to research, aside from a high preference for pasta and white meat as well as a low preference for vegetables and fish, the diet of sportspersons is characterised by insufficient consumption of vegetables and cereals [Ubeda *et al,*. 2010; Iglesias-Gutierrez *et al.,* 2008].

Biochemical analysis of the nutritional value of various products and dishes, taking into account the current dietary preferences of various population groups, is reflected by supplementation and updating of the tables of nutritional values that were published by Kunachowicz *et al.* [2005], and were a subject of research by other authors [Lebiedzińska *et al.,* 2004, 2005; Przygoda *et al.,* 2009; Ratkovska *et al.,* 2009]. Developing a list of food products that were subjected to analytical evaluation is helpful in designing a reliable tool that can be used for planning and rationalization of the nutritional model. It is particularly important in view of the differences between the results of theoretical calculations and those of analytical studies [Gielecińska & Szponar, 2005].

CONCLUSIONS

1. Grilled chicken salad is characterised by high contents of protein and dietary fibre and a favourable fatty acid profile, which substantiates its use as part of the balanced diet, also for sportspersons.

2. Spaghetti with tomatoes and parmesan cheese is characterised by a high content of digestible carbohydrates that can be a source of energy for athletes, and additionally supplies them with dietary fibre and protein.

3. Determination of the nutritional value of various dishes, including those preferred by athletes, affords the possibility of including them in consciously-planned balanced nutritional servings for physically-active individuals.

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