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Functional dependence of energy intake relative to the fat content in different types of cheeses

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Abstract

Nowadays, on the market, consumers can find a large number of cheese types, whose diversity is based on differences in texture, functional properties, flavor and aroma. High energy intake provided by placing cheese in the diet is due to its high content of nutrients. The goal of this paper is to test if there are any functional dependencies between some nutritional characteristics (energy intake relative to the fat content) in case of 20 different cheeses (including fresh, soft-ripened, semi-hard, hard, pasta filata, blue cheese and low fat varieties).

The samples were analyzed for their chemical composition (proteins, fat, and carbohydrates). The protein content of the samples was estimated by the Kjeldahl method; the fat was determined by Soxhlet extraction method; total carbohydrates were calculated by difference. The energy (caloric) values in case of analyzed cheese types were calculated by using the Atwater energy conversion factors.

The data were statistically processed using Statistica 10. The results look for the existence for statistically significant linear correlations and functional dependencies between some nutritional characteristics of the analyzed cheese types. From the obtained data we can observe a strong linear relationship between energy and fat values, aspects on which the linear dependence of energy relative to fat content is based.

Keywords: cheese, energy, fat, functional dependence

1. Introduction

Since the ancient times, the process of making cheese was considered an art. One of the reasons that led to cheese making was to turn a short-shelf food product into a stable product that can be kept for long periods of time [1].

In our days, cheese industry developed a multitude of cheese varieties, each with its own taste, texture and nutritional profile. From the nutritional point of view, cheese is a food product that contains high levels of essential nutrients (lipids, proteins, vitamins, minerals), which gives him the status of energy-rich food [2].

2. Materials and Methods

2.1. Materials

The research material was represented by 20 types of cheese – including fresh, soft-ripened, semi-hard, and hard, pasta filata, blue cheese and low fat varieties). All samples were bought from local markets and refrigerated at 4°C until analysis.

Some chemical and nutritional characteristics were determined, and for each parameter, samples were analyzed in triplicate.

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2.2. Methods

The samples were analyzed for their chemical composition (moisture, proteins, fat, and carbohydrates) through AOAC procedures [3].The protein content (N × 4.38) of the samples was estimated by the Kjeldahl method; the fat was determined by extracting a known weight of sample with petroleum ether, using a Soxhlet apparatus; the ash content was determined by incineration at 550 ± 15 °C. Total carbohydrates were calculated by difference. The energy contribution was calculated according to the following equation: Energy (kcal) = 4 × (g protein + g carbohydrate) + 9 × (g fat) [4].

The many varieties of cheese on the market are distinguished by the variability of their composition and implicitly by their varied nutritional intake, which makes this food a product destined for different categories of consumers. Cheese composition mainly consists of fat, protein, as well as vitamins, minerals and trace elements [5].

The purpose of this paper was to test the existence of functional dependencies between some nutritional characteristics (content of fat and value of energy) in case of 20 different cheese samples (including fresh, soft-ripened, semi-hard, hard, pasta filata, blue cheese and low fat varieties).

Coker et al., (2005), has shown that there is a wide range of physico-chemical and multivariate statistical methods that have been applied in order to characterize the cheeses in biochemical and nutritional terms, and a combination of these methods are useful for classification and predictive modelling purposes [6].

In terms of energy (caloric) intake, the most important component of milk used for cheese production is fat content, influenced by the lactation stage, season, feed, animal genotype, etc. [7]. According to Bylund (1995), the presence of fat in cheese influences the texture, taste, aroma and consistency [8].

Cheese quality varies according to the fat percentage of the raw milk used in cheese making [9]. Also, the cheese flavors are dependent on fatty acid from the milk and the other flavor that are developing during cheese ripening [10].

Cheese is also an important source of proteins and amino acids. According to Tomé et al (2002) cheese consumption provides all essential amino acids (except methionine and cysteine) in more than the recommended quantities for children or adults [11]. Not only the proteins and amino acids play an important role in case of nutritional value of cheese, but also bioactive peptides [12].

Knowing the energy value of a food is important for nutritional assessment, food labeling and consumer education [4,13]. In case of cheese, the fat and protein contents are essential for determining the energy value of the cheese, as carbohydrates are in small quantities or even in traces [14].

2.3.Statistical Analysis

All the data were statistically processed using the Statistica10 program. For the sake of simplicity in our statistical analysis, energy and fat were respectively denoted by E and F.

Basic descriptive statistics for the analyzed parameters (mean, minimum, maximum, lower quartile, upper quartile, range, variance, standard deviation, coefficient of variation, skewness and kurtosis) are shown in Table.1

Summary statistics for fat (F) are shown in Figure 1 From the data analysis, we observed that mean of fat values for studiated cheese is 26.17g/100g; minimum of fat values for studiated cheese is 3.9 g/100g (Cottage cheese); maximum of fat values for studiated cheese is 47.4 g/100g (Cream cheese); lower and upper quartiles of fat values for studiated cheese are 20.6 and 32.8 respectively; variance of fat values for studiated cheese is 112.08; standard deviation of fat values for studiated cheese is 10.58; skewness and kurtosis of fat values for studiated cheese are -0.53 and 0.32 respectively.

Frecquancy table for fat are presented in Table 2. From the presented data, it can be observed that 2 cheeses (Cottage cheese and Frommage frais) have fat values between 0 and 10 g/100g; 2 cheeses (Ricotta and Cheddar low fat content) have fat values between 10 and 20 g/100g; 7 cheeses (Brie, Cammembert, Danish blue, Edam, Emmental, Feta and Mozzarella) have fat values between 20 and 30 g/100g; 8 cheeses (Caerphilly, Cheddar, Cheshire, Gouda,Gruyere, Parmezan, Roquefort and Stillton) have fat values between 30 and 40 g/100g and 1 cheese (Cream cheese) have fat values between 40 and 50 g/100g.

Summary for energy are shown in Figure 1. We observed that mean of energy values for studiated cheese is 323 kcal/100g; minimum of energy values for studiated cheese is 98 kcal/100g (Cottage cheese); maximum of energy values for studiated cheese is 452 kcal/100g (Parmezan); lower and upper quartiles of energy values for studiated cheese are 275 kcal and 395.5 kcal respectively; variance of energy values for studiated cheese is 10860.52 kcal; standard deviation of energy values for studiated cheese is 104.21 kcal;skewness and kurtosis of energy values for studiated cheese are -1,06 and 0,29 respectively.

Table 1. Basic descriptive statistics for the analyzed parameters

Variable	Descriptive Statistics										
	Mean	Minimum	Maximum	Lower Quartile	Upper Quartile	Range	Variance	Std.Dev.	Coef.Var.	Skewness	Kurtosis
F	26,1700	3,90000	47,4000	20,6000	32,8000	43,5000	112,08	10,5870	40,45467	-0,53578	0,329595
E	323,0000	98,00000	452,0000	275,0000	395,5000	354,0000	10860,53	104,2138	32,26435	-1,06042	0,294078

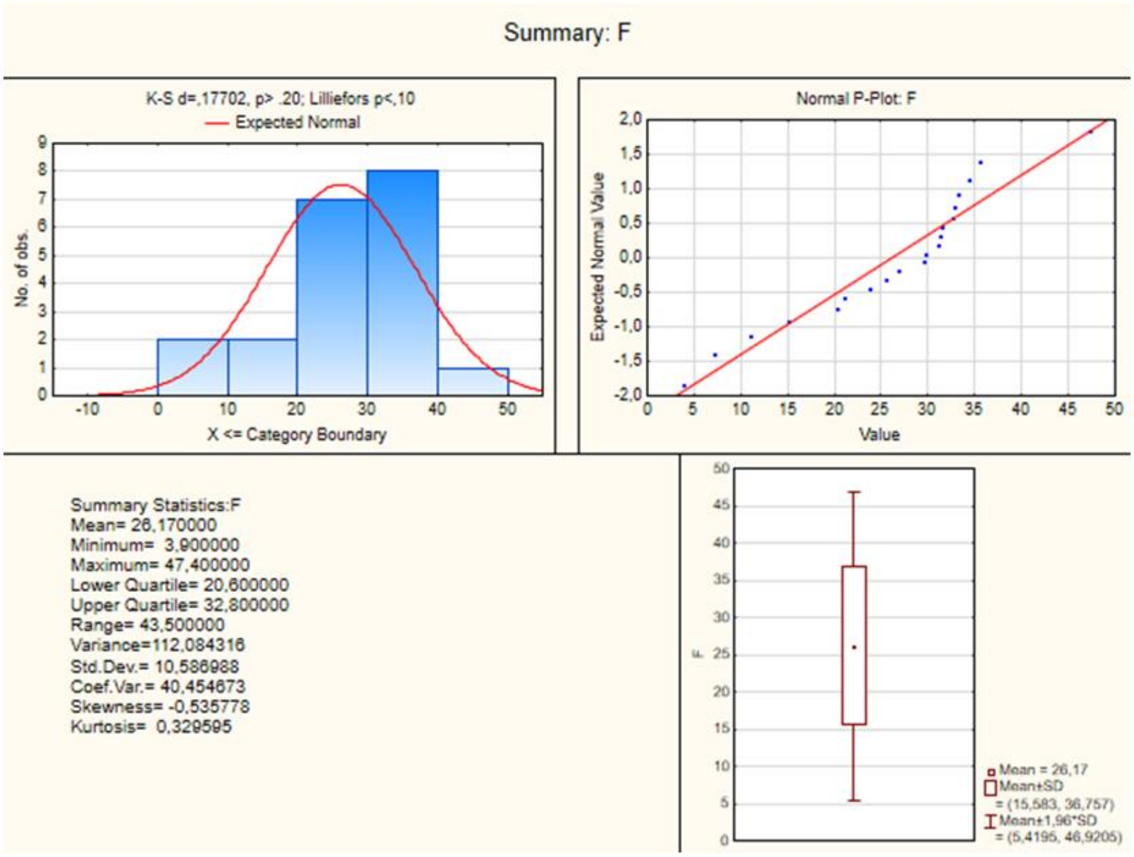

***Figure 1**.* Summary statistics for fat (F) in case of different type of cheese

Table 2. Frequency table for fat (F)

Category	Frequency table: F					
	Count	Cumulative Count	Percent of Valid	Cumul % of Valid	% of all Cases	Cumulative % of All
-10,0000<x<=0,000000	0	0	0,00000	0,0000	0,00000	0,0000
0,000000<x<=10,00000	2	2	10,00000	10,0000	10,00000	10,0000
10,00000<x<=20,00000	2	4	10,00000	20,0000	10,00000	20,0000
20,00000<x<=30,00000	7	11	35,00000	55,0000	35,00000	55,0000
30,00000<x<=40,00000	8	19	40,00000	95,0000	40,00000	95,0000
40,00000<x<=50,00000	1	20	5,00000	100,0000	5,00000	100,0000
Missing	0	20	0,00000		0,00000	100,0000

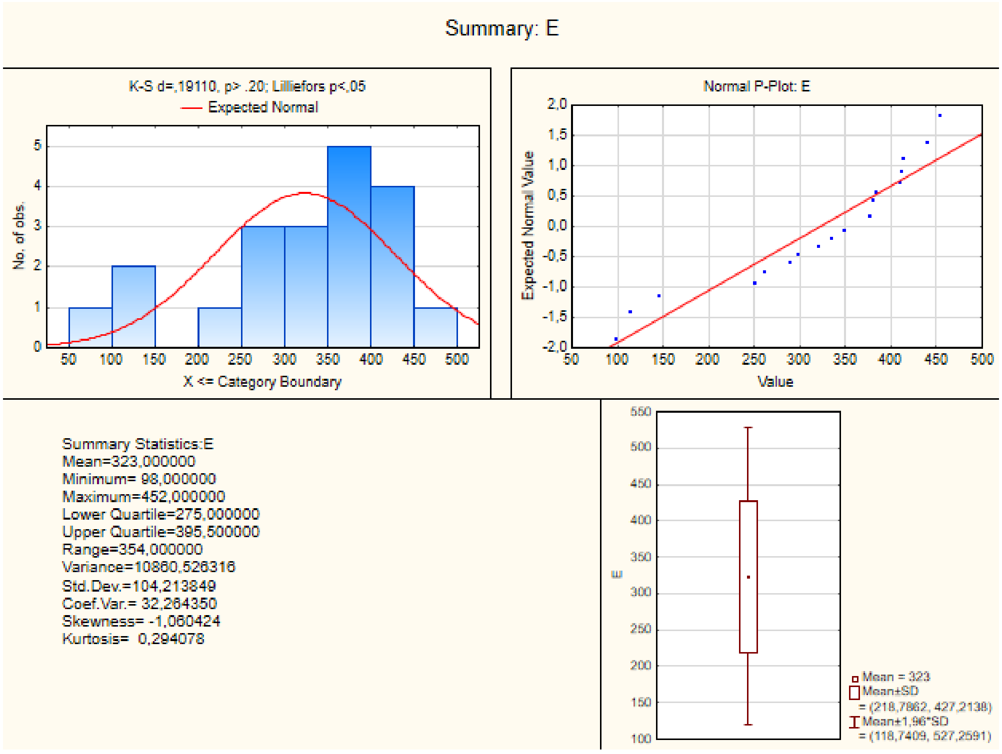

Figure 2. Summary statistics for energy (E) in case of different type of cheese

Table 3. Frequency table for energy (E)

Category	Frequency table: E					
	Count	**Cumulative Count**	**Percent of Valid**	**Cumul % of Valid**	**% of all Cases**	**Cumulative % of All**
50,00000<x<=100,0000	1	1	5,00000	5,0000	5,00000	5,0000
100,0000<x<=150,0000	2	3	10,00000	15,0000	10,00000	15,0000
150,0000<x<=200,0000	0	3	0,00000	15,0000	0,00000	15,0000
200,0000<x<=250,0000	1	4	5,00000	20,0000	5,00000	20,0000
250,0000<x<=300,0000	3	7	15,00000	35,0000	15,00000	35,0000
300,0000<x<=350,0000	3	10	15,00000	50,0000	15,00000	50,0000
350,0000<x<=400,0000	5	15	25,00000	75,0000	25,00000	75,0000
400,0000<x<=450,0000	4	19	20,00000	95,0000	20,00000	95,0000
450,0000<x<=500,0000	1	20	5,00000	100,0000	5,00000	100,0000
Missing	0	20	0,00000		0,00000	100,0000

Table 4. Univariate tests of significance for the regression coefficients

Effect	Univariate Tests of Significance for E				
	SS	**Degr. of Freedom**	**MS**	**F**	**p**
Intercept	15989,8	1	15989,8	15,7263	0,000907
F	188048,3	1	188048,3	184,9489	0,000000
Error	18301,7	18	1016,8		

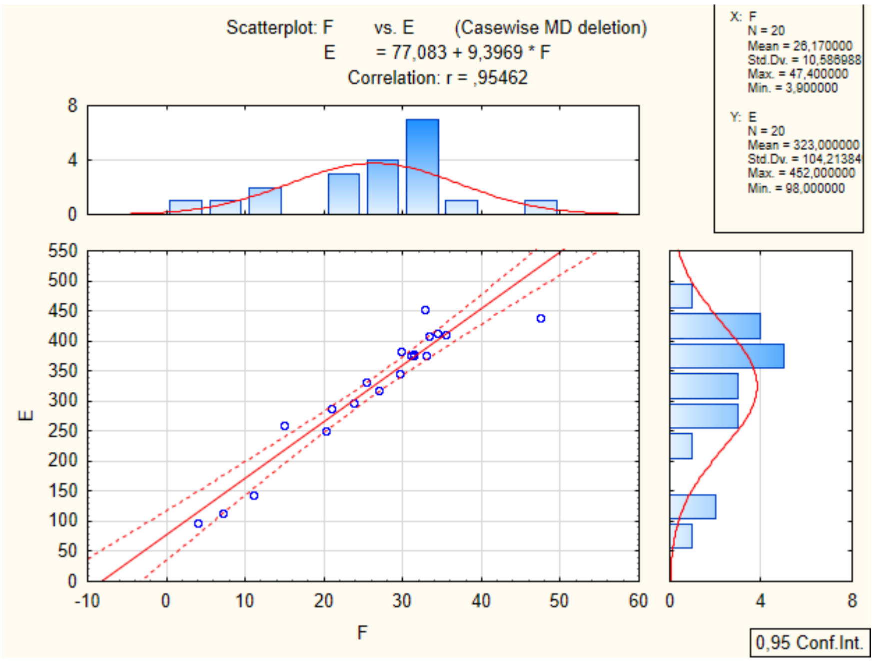

Figure 3. Linear dependence of the fat (F) relative to energy (E).

Table 5. Parameter estimates for linear dependence of the fat (F) relative to energy (E).

Effect	**Parameter Estimates**					
	E Param.	**E Std.Err**	**E t**	**E p**	**-95,00% Cnf.Lmt**	**+95,00% Cnf.Lmt**
Intercept	77,08260	19,43765	3,96563	0,000907	36,24562	117,9196
F	9,39692	0,69097	13,59959	0,000000	7,94524	10,8486

Frecquancy table for energy are presented in Table 3. From the analysed data we can observe that 1 cheese (Cottage cheese) have energy value between 50 and 100 kcal/100g; 2 cheeses (Fromage frais and Ricotta) have energy values between 100 and 150 kcal/100g; 1 cheeses (Feta) have energy values between 200 and 250 kcal/100g; 3 cheeses (Cammembert, Cheddar low fat and Mozzarella) have energy values between 250 and 300 kcal/100g; 3 cheeses (Brie, Danish blue and Edam) have energy values between 300 and 350 kcal/100g; 5 cheeses (Caerphilly, Cheshire, Emmental, Gouda and Roquefort) have energy values between 350 and 400 kcal/100g; 4 cheeses (Cheddar, Cream cheese, Gruyere and Stillton) have energy values between 400 and 450 kcal/100g; 1 cheeses (Parmezan) have energy values between 450 and 500 kcal/100g.

A linear regression analysis of the energy based on the fat content was performed (see Table 4). It was determined that the proportion of variance in the energy (188048.3) was statistically significant (F=184.9489, df=1) for p value under 0.05, where the F ratio provided the test of statistically significance.

The regression line $y=b_0+b_1x$ is the linear equation used to fit the best straight line to the data (see Figure 3). The dependent variable E was expressed (see Table 5) as the equation.

$$E = 77{,}083 + 9{,}3969*F$$

The 95% confidence interval for the slope 9.3969 was (+7.94, +10.84) and the 95% confidence interval for the intercept 77.083 was (+36.24, +117.91) which provides the lower and upper bounds for the unstandardized regression coefficients. We noted that the 95% confidence interval does not include 0 suggesting that the slope is significantly different than 0 which means there is a strong linear relationship between E and F. In fact, the strong positive linear correlation was reported by the Pearson linear correlation coefficient r=+0.95 and determination coefficient r^2=0.91 (see Figure 3).

4. Conclusion

One of the major concerns of today's cheese consumers is the supply of important and essential nutrients. Recent studies are no longer focused on the production of high quality cheese varieties, but on the commercialization of cheese as a functional food.

From the presented data, we observed that regarding fat values for studiated cheese, one group of 7 cheeses (Brie, Cammembert, Danish blue, Edam, Emmental, Feta and Mozzarella) have fat values between 20 and 30 g/100g. On the other hand, 3 of these cheeses (Cammembert, Cheddar low fat and Mozzarella) have energy values between 250 and 300 kcal/100g, and another 3 cheeses (Brie, Danish blue and Edam) have energy values between 300 and 350 kcal/100g. All these cheese presented above are very different in terms of consistency, but are relating in terms of energy value and fat content. On the other hand, in case of energy values for studiated cheese, it can be remarked another group of 5 cheeses (Caerphilly, Cheshire, Emmental, Gouda and Roquefort) have energy values between 350 and 400 kcal/100g. All cheeses from this group are rennet-coagulated. Four types (Caerphilly, Gouda, Cheshire, Emmental) of these cheese are internal bacterially-ripened and one (Roquefort) internal mould-ripened cheese. In terms of consistency, are semi-soft cheese.

This paper underline the existence of some significant positive linear correlations and functional dependencies between the two nutritional characteristics fat (F) and energy (E) for 20 different cheese samples (including fresh, soft-ripened, semi-hard, hard, pasta filata, blue cheese and low fat varieties).

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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