STUDY ON THE NUTRITIONAL QUALITY OF REFRIGERATED BEEF HAMBURGERS

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Abstract

The study aimed a comparative analysis of the nutritional quality of the refrigerated beef hamburgers by determining the gross chemical composition (the content in lipids, water, salt, ash and proteins, including the proportion of collagen) and respectively of theirs energy value. Thirty products were analyzed, five for each producer (manufacturers coding: A, B, C, D, E and F). The proteins, lipids, collagen, salt and water content was determined using the automated analyzer Food Check (infrared spectrophotometer); mineral substances were determined by calcination at 550 ^{0}C and the carbohydrates content and energy value were determined by calculation, using conventional formulas. The most important differences between the all six type products analyzed, have targeted the content of lipids, with difference of 56.35% (21.40% lipids for product F, compared with 12.06% lipids for product A). Only producer B, of the six studied, did not add salt in the composition of hamburgers. The obtained data were statistically processed by classical methods and through the test for analysis of variance ANOVA (Graph Pad Prism 8.1 software). Mostly significant ($p<0.01$) and very significant differences ($p<0.001$) were observed between the all hamburger categories analyzed, at the level of chemical composition with exception of protein content where predominantly insignificant differences were observed ($p>0.05$).

Key words: hamburger, proteins, collagen, lipids, salt

INTRODUCTION

In the last decades, changing lifestyles have led to shifting consumer's preferences to purchase more processed-meat (or partially-prepared) products than fresh meat [10, 14]. Beef sector has remained more unchanged, gradually losing its share of the meat market [13, 14]. Therefore, the beef industry seeks to develop newly processed or partially-prepared products but understanding consumers' sensory perception of these products is fundamental to ensure their acceptability.

The beef hamburgers are preferred, more recently in our country, being like a trend especially for young consumers, and their overall quality is very important. Variation in meat quality depends on a wide range of productive (e.g., breed, sex, age, slaughter weight and diet) and technological factors (e.g., management, refrigeration and aging time). Heifers deposit more fat than bulls, and their meat presented better characteristics in terms of eating quality, because a greater amount of fat and unsaturated fatty acids in the meat is closely related to a better sensory evaluation [13, 21]. Was reported leaner carcasses in bulls than heifers, and in a sensory panel, meat from heifers was perceived as more tender and more acceptable [4, 13]. However fresh beef meat has a short shelf life, ranging from three to five days when stored at 4ºC [16] due to its high water content and chemical composition, contributing significantly to meat spoilage [3, 6, 11]. In addition, oxygen has a negative effect on meat quality [12], where lipid oxidation, after microbial growth, is characterized as the primary cause of food alteration [22]. Active-edible films can be used as an effective alternative of packaging technology for improving food safety and fresh meat quality [2].

The study aimed a comparative analysis of the nutritional quality of the refrigerated beef hamburgers sold in Iasi, by determining the gross chemical composition (the content in lipids, water, salt, ash and proteins,

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including the proportion of collagen) and respectively of their energy value.

MATERIALS AND METHODS

Thirty products were analysed, five for each producer (manufacturers coding: A, B, C, D, E and F). All the products were sold at the tray containing two hamburgers. From the two hamburgers, a single test sample was obtained. The samples were chopped and homogenized with an electric shredder.

The water, proteins and lipids content were determined using the Food Check Near Infrared Spectrophotometer (NIRS technology); the energy value was determined by calculation using conventional formulas and crude ash content was assessed by calcinations (at 550°C for 16 h after a preliminary carbonization). The energy conversion factors were: 4.27 for proteins, 9.02 for lipids and 3.87 for carbohydrates (according specific Atwater factors, FAO relations, 2003) [8]. The achieved results were statistically processed through the main descriptors computation (arithmetic mean, $\bar{x}$, standard deviation, s, and coefficient of variation, V%, and by analysis of variance test (ANOVA multiple comparisons), using the GraphPad Prism 8.1 software.

RESULTS AND DISCUSSIONS

The most important differences between the all six type products analysed (Tables 1-6), have targeted the content of lipids, with difference of 56.35% (21.40% lipids for product F, compared with 12.06% lipids for product A, followed by manufacturer E with 21.08% lipids).

Table 1 Chemical composition and energy value for A hamburgers

Chemical components	$\bar{X} \pm s_{\bar{x}}$	S	V%	Min.	Max.
Lipids%	12.06±0.23	0.92	7.64	11.30	13.90
Proteins%	17.45±0.10	0.42	2.40	16.30	17.80
Collagen%	3.09±0.02	0.09	2.99	2.85	3.20
Water%	67.66±0.16	0.66	0.97	66.10	68.20
Ash%	2.16±0.01	0.02	1.12	2.12	2.20
Salt%	1.69±0.05	0.18	10.79	1.40	2.10
Dry matter%	32.34±0.16	0.66	2.04	31.80	33.90
Organic matter%	30.18±0.17	0.67	2.21	29.64	31.78
Carbohydrates %	0.68±0.08	0.32	47.00	0.20	1.65
Energy kcal/100g	185.88±1.78	7.11	3.83	179.63	201.44
Energy kJ /100g	777.72±7.44	29.76	3.83	751.59	842.82

s= standard deviation; V%=coefficient of variation.

The proteins content was higher for producer B, 18.12%, followed by manufacturer A with 17.45%, D, with 17.09% and C with 16.96%. The lowest value was observed for producer E with 16.53% proteins (Table 5).

Table 2 Chemical composition and energy value for B hamburgers

Chemical components	$\bar{X} \pm s_{\bar{x}}$	S	V%	Min.	Max.
Lipids%	18.09±0.48	1.72	9.50	16.20	20.70
Proteins%	18.12±0.11	0.40	2.19	17.50	18.50
Collagen%	2.94±0.04	0.14	4.78	2.75	3.09
Water%	62.76±0.37	1.33	2.12	60.80	64.10
Ash%	0.85±0.01	0.02	2.23	0.83	0.87
Salt%	-	-	-	-	-
Dry matter%	37.24±0.37	1.33	3.58	35.90	39.20
Organic matter%	36.39±0.37	1.32	3.63	35.05	38.33
Carbohydrates %	0.18±0.04	0.15	87.68	0.07	0.47
Energy kcal/100g	241.26±3.83	13.79	5.72	226.92	262.01
Energy kJ /100g	1009.42±16.01	57.71	5.72	949.44	1096.27

s= standard deviation; V%=coefficient of variation

For the water content, the higher values were observed at the level of producer A, with average value of 67.66%, followed by producer C with 63.08%, and the lowest average value was observed for producer F with 60.10% (Table 6).

Table 3 Chemical composition and energy value for C hamburgers

Chemical components	$\overline{X} \pm s_{\overline{x}}$	S	V%	Min.	Max.
Lipids%	16.60±2.54	5.68	34.19	15.30	17.90
Proteins%	16.96±2.69	6.01	35.41	15.80	17.90
Collagen%	2.49±0.56	1.26	50.47	2.16	2.78
Water%	63.08±11.47	25.65	40.66	60.10	66.90
Ash%	1.66±0.67	1.49	90.13	1.47	1.84
Salt%	1.10±0.90	2.03	81.97	0.90	1.30
Dry matter%	36.92±6.58	14.70	39.82	33.10	39.90
Organic matter%	35.26±6.24	13.96	39.58	31.32	38.24
Carbohydrates %	1.70±0.73	1.64	96.28	0.98	3.63
Energy kcal/100g	228.74±45.62	12.01	44.60	212.81	242.19
Energy kJ /100g	957.06±194.05	33.90	45.34	890.41	1013.31

s= standard deviation; V%=coefficient of variation

The collagen content was higher for manufacturer A, 3.09%, followed by producer B, 2.94% and the lowest average value was observed for producer C, 2.49%.

Table 4 Chemical composition and energy value for D hamburgers

Chemical components	$\overline{X} \pm s_{\overline{x}}$	s	V%	Min.	Max.
Lipids%	18.99±0.91	2.58	13.60	14.80	21.60
Proteins%	17.09±1.30	3.69	21.58	15.50	19.30
Collagen%	2.66±0.72	2.03	76.12	2.42	3.01
Water%	60.79±7.08	20.03	32.95	60.00	63.40
Ash%	1.77±0.83	2.33	31.93	1.33	1.85
Salt%	1.17±0.92	2.59	21.47	1.01	1.30
Dry matter%	39.21±4.17	11.80	30.10	36.60	40.00
Organic matter%	37.44±3.93	11.12	29.69	34.76	38.27
Carbohydrates %	1.37±1.30	3.69	69.62	0.64	6.32
Energy kcal/100g	249.53±32.53	92.01	36.87	228.39	265.50
Energy kJ /100g	1044.02±139.49	94.52	37.79	955.60	1110.85

s= standard deviation; V%=coefficient of variation

The ash content was higher for manufacturer A (Table 1), 2.16%, followed by producer E, 1.83%, and the lowest average value was observed for producer B, 0.85% (Table 2), probably because this producer doesn't have added salt in the composition of hamburger.

Table 5 Chemical composition and energy value for E hamburgers

Chemical components	$\overline{X} \pm s_{\overline{x}}$	s	V%	Min.	Max.
Lipids%	21.08±0.09	0.25	1.21	20.80	21.60
Proteins%	16.53±1.12	3.17	19.21	15.50	17.60
Collagen%	2.57±0.73	2.07	80.29	2.42	2.78
Water%	60.41±7.00	19.79	32.75	60.00	60.60
Ash%	1.83±0.82	2.33	27.21	1.78	1.85
Salt%	1.17±0.92	2.59	21.47	1.01	1.30
Dry matter%	39.59±4.23	11.96	30.22	39.40	40.00
Organic matter%	37.76±3.98	11.27	29.85	37.55	38.17
Carbohydrates %	0.16±1.04	2.94	82.80	0.13	1.26
Energy kcal/100g	261.26±33.93	95.97	36.73	259.07	265.50
Energy kJ/100g	1093.12±145.36	11.15	37.61	1083.97	1110.85

s= standard deviation; V%=coefficient of variation

The salt content was higher for producer A, 1.69%, followed by manufacturer E and D with 1.17%, by C with 1.10% and by F with, 0.93%.

Only producer B, of the six studied, did not add salt in the composition of hamburgers, the manufacturer specifying that on the label of products. From this point of view, the product B is the healthier choice for consumer, especially for those with hypertension or cardiovascular affections.

Table 6 Chemical composition and energy value for F hamburgers

Chemical components	$\overline{X} \pm s_{\overline{x}}$	s	V%	Min.	Max.
Lipids%	21.40±7.51	13.01	60.80	20.80	21.80
Proteins%	16.73±5.61	9.71	58.03	15.20	18.40
Collagen%	2.57±0.18	0.30	11.87	2.30	2.80
Water%	60.10±23.31	40.38	67.18	58.41	61.30
Ash%	1.49±0.62	1.07	71.62	1.23	1.85
Salt%	0.93±0.84	1.46	56.57	0.70	1.20
Dry matter%	39.90±15.06	26.09	65.39	38.70	41.59
Organic matter%	38.41±14.45	25.04	65.19	37.47	40.20
Carbohydrates %	0.27±1.11	1.93	76.51	0.15	0.47
Energy kcal/100g	265.54±107.18	185.64	69.91	259.07	274.17
Energy kJ /100g	1111.00±452.34	783.47	70.52	1083.97	1147.14

s= standard deviation; V%=coefficient of variation.

Sodium chloride plays an important role in products' conservation and in sensorial characteristics, such as taste intensity, which decreases when salt is reduced [5, 15].

In many industrialized countries sodium ingestion exceeds nutritional recommendations. Excessive sodium intake is associated with hypertension and the occurrence of cardiovascular diseases. Sodium chloride, its main sodium source, is associated with an increase in blood pressure when consumed above 6 g/day/person [15].

Epidemiological studies have shown low rates of arterial hypertension cases in populations who intake less than 3 g of salt/day and high rates in populations that consume more than 20 g of salt/day [17]. Research in European countries [7] has shown that meat and meat products contribute to 20% of sodium intake in the consumer diet. Thus, the development of meat products with low salt rates is important not only to the hypertensive part of the population.

Pellattiero et al., 2018, [13] found for hamburgers sold in North East of Italy, protein ranged from 15.9 to 17.0%, fat from 9.1 to 12.9% and ash from 1.99 to 2.07% . Unfortunately, from this point of view, the majority of hamburgers sold in North East of Romania had, in composition, more fat.

In a ample study made in Brazil in collaboration with Spain [5], using meat from the rib section of the muscle *Multifidi dorsi* (without adding fat), herbs and salt found in hamburgers 72.43 % water, 22.17 % proteins, 2.28% lipids and 2.54 % ash.

The proteins and ash content of hamburgers from present study are in line with the hamburgers sold in Italy, and are smaller compared with that from previously study of Carvalho, et al., 2017 [5].

It is normally observed that in muscle groups where we find a lower amount of fat, we will meet a higher amount of water and protein.

The most important differences between the all six type products analyzed, have targeted the content of lipids (Fig. 1.), with difference of 9.34% percentage points (minimum values of 12.06% lipids for product A, compared with maximum values of 21.40% lipids for product F).

The proteins content (Fig. 2) varied with 1.59 percentage points between manufacturer's (minimum values of 16.59% for product E, compared with maximum values of 18.12% for product B).

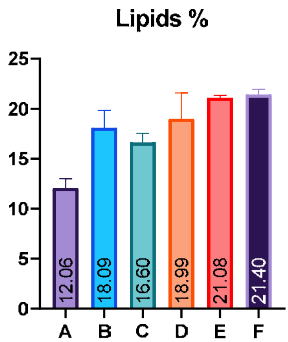

Fig. 1 The lipid content of hamburger A to F

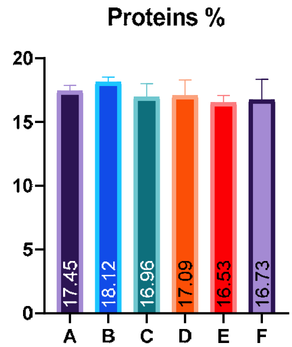

Fig. 2 The lipid content of hamburger A to F

The average values of collagen content (Fig. 3) presented differences of 0.60 percentage points, with lower values for product C (2.49%) and higher for product A (3.09%).

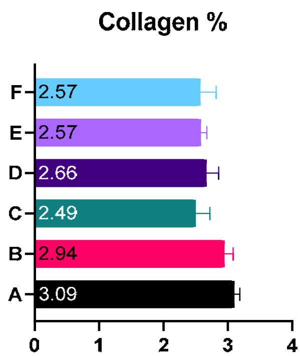

Fig. 3 The collagen content of hamburger A to F

The water content of hamburgers (Fig. 4) varied with 7.56 percentage points between manufacturers's (with minimum average values of 60.10% for product F, compared with maximum values of 18.12% for product A).

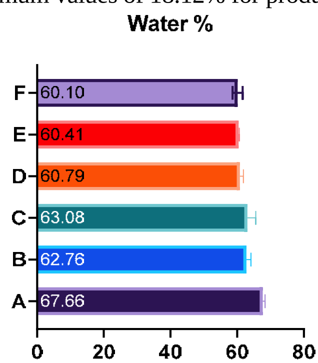

Fig. 4 The water content of hamburger A to F

The average values of ash content (Fig. 4) varied with 1.31 percentage points, presenting maximum values for producer A, 2.16%, and minimum values for product B, 0.85% probably because the manufacturer B is the only one without adding of salt in the composition of hamburgers. The salt content (Fig. 6) varied with 1.69% percentage points (0% for product B compared with 1.69% for A product).

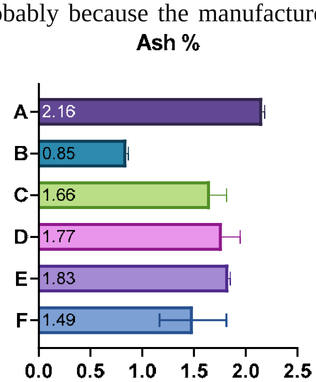

Fig. 5 The ash content of hamburger A to F

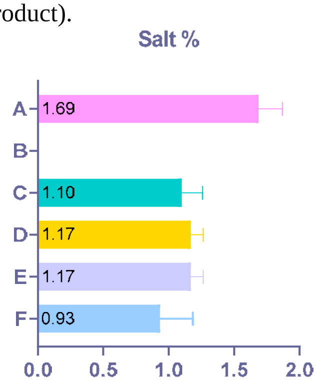

Fig. 6 The salt content of hamburger A to F

For the organic matter (O.S.%) was observed differences of 8.23 percentage points, with minimum average limits of 30.18% for A product, and maximum of 38.41% for F product (Fig. 7).

For the dry matter (DM%) the differences observed was of 7.56 percentage points, with minimum average values of 32.34% for producer A and maximum of 39.90%, for producer F (fig. 8).

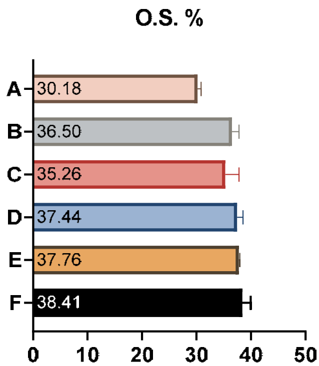

Fig. 7 The organic matter content of hamburger A to F

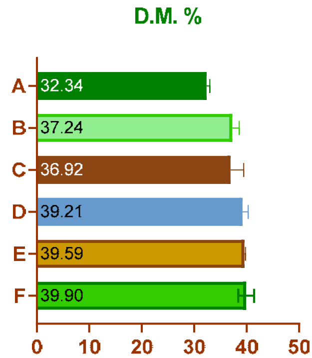

Fig. 8 The dry matter content of hamburger A to F

The energy value presented differences of 79.66 kcal/100 g product, with maximum values of 265.54 kcal/100 g for product F and minimum values of 185.66 kcal/100 g for product A (Fig. 9).

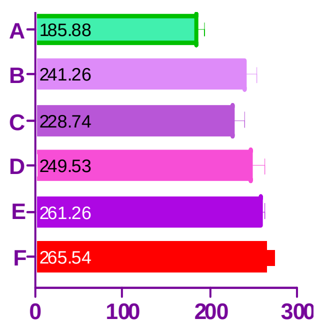

Fig. 9 The energy value of hamburger A to F

Worldwide, many studies are made for improving the nutritional quality of beef meat. Recently, the health effects of consuming α-linolenic acid (ALA, 18:3n-3) have been debated, and most beneficial effects of omega-3's have been attributed to ALA's elongation and desaturation products: eicosapentaenoic acid and docosahexaenoic acid. ALA may have a larger role to play in protecting against cardiovascular and other diseases [18, 19].

Feeding sources of ALA including fresh and conserved forage together with oilseeds have been found to enrich ALA in beef [20].

Feeding oilseeds in diets with a high proportion of forage can also enrich beef with rumen bio hydrogenation intermediates (BHI) derived from dietary polyunsaturated fatty acids (PUFA). BHI such as t11–18:1 (vaccenic acid) and c9, t11–18:2 (rumenic acid) may also help protect against a number of diseases from cancer and inflammatory diseases to type II diabetes and post-menopausal osteoporosis [1, 9]. Considerable efforts have, therefore, gone into increasing n-3 fatty acids and PUFA-BHI with variable success in beef being considered like a functional food [19, 20].

Table 7 The statistical significance of the differences on chemical composition and energy value of beef hamburger (products A to F)

ANOVA	Lipids		Proteins		Collagen		Water		Ash		Salt		D.M.		O.S.		Energy kcal/100g	
	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value	S	P value
A vs. B	***	<0.0001	ns	0.1761	ns	0.0854	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001
A vs. C	***	<0.0001	ns	0.7969	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001
A vs. D	***	<0.0001	ns	0.8723	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001
A vs. E	***	<0.0001	ns	0.0671	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001
A vs. F	***	<0.0001	ns	0.6543	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001	***	<0.0001
B vs. C	ns	0.3857	ns	0.0530	***	<0.0001	ns	0.9955	***	<0.0001	***	<0.0001	ns	0.9955	ns	0.3848	ns	0.2178
B vs. D	ns	0.7443	*	0.0388	**	0.0017	**	0.0069	***	<0.0001	***	<0.0001	**	0.0069	ns	0.5214	ns	0.4920
B vs. E	***	0.0005	***	0.0003	***	<0.0001	***	0.0008	***	<0.0001	***	<0.0001	***	0.0008	ns	0.2144	**	0.0012
B vs. F	*	0.0108	ns	0.0604	**	0.0038	*	0.0124	***	<0.0001	***	<0.0001	*	0.0124	ns	0.1539	**	0.0081
C vs. D	ns	0.0622	ns	0.9997	ns	0.3754	*	0.0167	ns	0.4572	ns	0.9568	*	0.0167	*	0.0278	*	0.0120
C vs. E	***	<0.0001	ns	0.9098	ns	0.9351	**	0.0034	ns	0.0672	ns	0.9568	**	0.0034	**	0.0079	***	<0.0001
C vs. F	***	0.0006	ns	0.9983	ns	0.9831	*	0.0147	ns	0.2984	ns	0.6018	*	0.0147	**	0.0093	***	0.0002
D vs. E	ns	0.0635	ns	0.6661	ns	0.8453	ns	0.9879	ns	0.8531	ns	>0.9999	ns	0.9879	ns	0.9949	ns	0.2301
D vs. F	ns	0.1602	ns	0.9813	ns	0.9388	ns	0.9557	**	0.0049	ns	0.1658	ns	0.9557	ns	0.8383	ns	0.2230
E vs F	ns	0.9994	ns	0.9984	ns	>0.9999	ns	0.9988	***	0.0003	ns	0.1658	ns	0.9988	ns	0.9651	ns	0.9899

ANOVA =Multiple Comparison's test Graph prism

n.s. (not significant) = p >0.05;

* (significant) = 0.05 > p> 0.01;

** (distinct significant) = 0.01 > p > 0.001;

*** (highly significant) = 0.001> p.

CONCLUSIONS

The most important differences between the all six type products analyzed have targeted the content of lipids, with difference of 56.35% (21.40% lipids for product F, compared with 12.06% lipids for product A). Only producer B, of the six studied, did not add salt in the composition of hamburgers. After a statistically processing of the data obtained through the ANOVA variance analysis test (GraphPad Prism 8.1 software), mostly significant ($p<0.01$) and very significant differences ($p<0.001$) were observed between the all hamburger categories analyzed, at the level of chemical composition, with exception of protein content where predominantly insignificant differences were observed ($p>0.05$).

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