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Physicochemical Quality Assessment of Brazilian Frozen Beef Imported into Algeria

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ABSTRACT

BACKGROUND: In recent decades, imported boneless and frozen beef has invaded the Algerian market. However, the true appreciation of the quality of this product can only be obtained by laboratory analyzes and examinations. **AIMS**: The aim of the current study was to assess physicochemical parameters of the imported boneless and frozen beef meat dedicated for human consumption. **METHODS**: Twenty (20) samples of neck, blade bolar, brisket, blade oyster, Forequarter (FQ)/hindquarter (HQ) shin-shank were purchased from the Regional Meat Office in Saida city, Algeria. Physicochemical parameters such as pH, water, ash, protein and fat content were analyzed according to standard procedures. **RESULTS**: Our results showed a highly significant variability concerning protein and fat content of the five categories of analyzed pieces (p=0.002). Fat content ranged from 0.43g to 4.04g per 100g of edible portion, for which we found low intramuscular fat contents in the lumps. However, the pH values obtained generally characterized RFN (Red, Firm, and Normal) meat. **CONSLUSIONS**: In view of the results obtained from this study, the overall chemical composition is satisfactory, except for the fat content which constitutes a parameter to be discussed and which depends on the taste of the consumer.

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1. INTRODUCTION

In Algeria, "Red Meat Industry" is based on cattle and sheep farms. However, camel and goat production represents marginal levels of production. This situation leads us to state that local meat production does not cover domestic market demand, which has led to the development of the import flow of frozen boneless meat, particularly bovine reaching 19 586 t (3 348 USD/t), during the first semester of year 2015 and 14 571 t (3 000 USD/t) during the second semester of the same year, according to the latest published data on the Algerian Ministry of Commerce's official website [1].

One of the major issues encountered by the meat industry, particularly the bovine sector, lies in high variability of the raw material, which means that products, of variable and uncontrolled quality, are placed on the market. This variability is linked to the biological diversity of the animals from which the meat is obtained. The key criteria for assessing overall meat quality are sensory quality, nutritional value, and processing suitability that is affected by physicochemical properties. Factors influencing physicochemical characteristics of meats are partly related to race, age, sex, and depend on the type of meat or dairy and the mode of driving too [2]. Diets, that constitutes one of the most important factors of variation, can modulate the importance of certain nutrients in meat, especially fats [3]. The aim of the current study was to assess the physicochemical parameters of the imported boneless and frozen beef meat from Brazil, dedicated for human consumption.

2. MATERIAL AND METHODS

2.1. Sampling and Preparation Methods

The sampling, carried out during our study, was based on the guidelines of both standards ISO and Algerian (NA) [4-10]. A total of forty-five (45) samples were intended for physicochemical assessment and sixty (60) for pH measurements.

2.2. Raw material

Basically, meat imported from Brazil was introduced in pieces (Neck, Blade bolar, Brisket, blade oyster, FQ/HQ shin-shank), boneless and frozen. The meat pieces were distributed to storage and ware housing locations in different cities across the country for wholesale or semi-wholesale distribution. The ORVO (Western Regional Meat) of Saida city represents the unique principal source to supply this material. After the cardboard boxes were opened, the plastic packaging bags were disinfected with a mixture of disinfectant products containing 60 ml of ethanol, 10 ml of hydrochloric acid and 30 ml of water. After that, pieces were placed on the cutting machine table, French model (BIRO®), disinfected using the same disinfectant. The cutting machine allows a quick mechanical cutting of meat slices preserving its frozen state. Each sample, purchased from each piece, weighed between 150 to 200 g, was packed in a sterile plastic bag, carefully sealed, labeled, then sent directly to the laboratory.

- **Defrosting in the refrigerator**

The treatment of samples for analysis required prior defrosting, since the meat in the frozen state presents a vitreous appearance that is difficult to handle. It should be noticed that this defrosting was not done completely. However, meat was considered thawed when it reached a temperature between -2 °C and + 2 °C [11]. After 30 minutes to 60 minutes of residence in the refrigerator, the sample had a manageable appearance and before it reached the defrosting temperatures, the dicing operation was initiated.

- Dicing

The specimen was sited in a vertical laminar flow hood (TelStar® AV 100, TelStar Industrial, Spain) which provided a sterile handling environment and was then cut into small dices using a sterile surgical blade placed in a knife.

- Homogenization by grinding

The diced meat, placed in a sterile "Stomacher" bag of 80 to 400 ml capacity, was then homogenized 1 to 2 times for 1 to 2 minutes in a peristaltic type homogenizer (Stomacher®, Seward and Co. Ltd., London, England).

- Proper Analysis

The physicochemical parameters were assessed according to the standards described above. The results of the study were statistically analyzed using the statistical program (StatView® 5.0, SAS Institute, Cary, USA). Student's *t*-test was used to compare the averages between the different samples. We considered the significant test for a value of $P<0.05$. A simple regression was also applied in order to demonstrate the correlation between the amount of protein and fats contained in meat samples.

3. RESULTS

Regarding proteins and lipids contents, our results showed significant differences among the studied samples. On the other hand, water and ash remained constant.

3.1. Lipid content

The lipid contents had a high coefficient of variation about 30%, as illustrated in Table 1. The mean of intramuscular fat contents of analyzed pieces (Figure 1) characterizes "lean meats"; for which the fat content seldom exceeds 5%, "moderate fat" between 5 and 7%, up to 10% in extreme cases and "fatty meat" 10-12%. Significant differences ($P<0.05$), between the fat contents in the analyzed pieces, were recorded, particularly between the blade oyster and the blade bolar, and between the blade oyster and the FQ/HQ shin-shank (Table 3). However, this meat always remains “lean meats”.

3.2. Proteins content

Table 1 shows the mean of protein content (20.80±1.63 g/100g). Compared to fats, the variability between the protein content for the five categories of analyzed pieces, was highly significant, especially between the blade oyster and the blade bolar, and the blade oyster and brisket (Table 4). A simple regression was used to determine the relationship between fat content and protein content (figure 2). In fact, the increase of lipid rate leads to the reduction of the levels of the proteins meat.

Table 1: Chemical composition of frozen beef

	Means ± SEM (g/100g)	Min – Max (g/100g)	C.V(%)
Moisture	75.25 ± 1.68 *	73 – 77	1.40
Protein	20.80 ± 1.63	19.12– 24.92	7.80
Fat	2.92 ± 0.87	0.43 – 4.04	29.70
Ash	1.09 ± 0.14	0.82 – 1.38	12.60

Means ± SEM Mean ± standard error of the mean, Min: Minimum, Max: Maximum, C.V: Coefficient of variation (calculated by dividing the standard deviation by the mean).

Table 2: Matrix correlation between different pieces according to intramuscular lipid content

	Neck	Blade bolar	Brisket	Blade oyster	FQ/HQ Shin-Shank
Neck		Ns	Ns	Ns	Ns
Blade bolar	Ns		Ns	p = 0.042	Ns
Brisket	Ns	Ns		Ns	Ns
Blade oyster	Ns	p = 0.042	Ns		p = 0.024
FQ/HQ Shin-Shank	Ns	Ns	Ns	p = 0.024	

NS Not significant, p< 0.05: difference Significant.

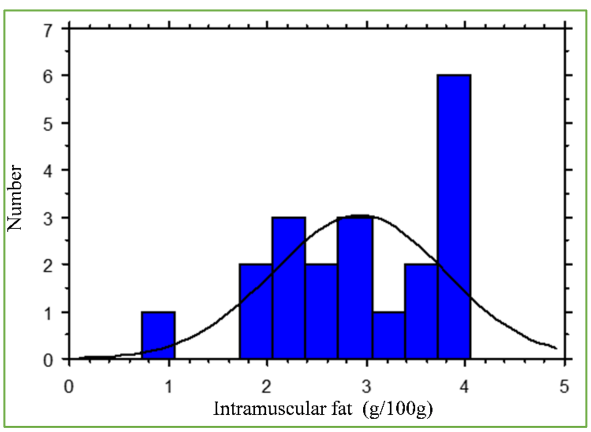

Figure 1: The average of intramuscular fat contents in the analyzed pieces

3.3. Moisture

The mean moisture of analyzed samples (Table 1) was 75.25±1.68 g/100g with limit values between 73 and 77 g/100g. The coefficient of variation was low (1.40%).

3.4. Ash content

As shown in table 4, the coefficient of variation of ash was found to be 12.84%. However, a stability of the content of these elements between the different pieces analyzed was also observed.

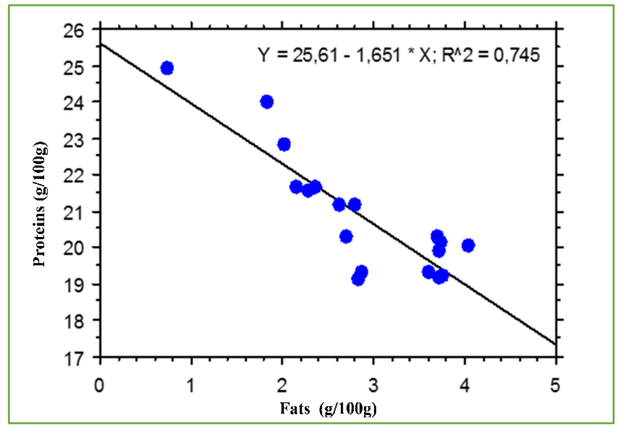

Figure 2: Regression graph between fat and proteins contents in different categories of analyzed pieces

Table 3: Matrix correlation between the different categories of pieces according to the protein content

	Neck	Blade bolar	Brisket	Blade oyster	FQ/HQ Shin-Shank
Neck		p =0.038	p =0.040	Ns	Ns
Blade bolar	p = 0.038		Ns	p = 0.002	Ns
Brisket	p = 0.040	Ns		p = 0.002	Ns
Blade oyster	Ns	p = 0.002	p = 0.002		p = 0.034
FQ/HQ Shin-Shank	Ns	Ns	Ns	p = 0.034	

NS Not significant, p< 0.05: difference Significant.

Table 4: Comparison of the chemical composition between the different categories of pieces

Composition (%)	Neck	Blade bolar	Brisket	Blade oyster	FQ/HQ Shin-Shank
Moisture	74.25 ± 1.5*	75.75 ± 0.96	76.00 ± 0.82	74.75 ± 0.50	75.25 ± 0.50
Dry matter	25.75 ± 1.5	24.25 ± 0.96	24.00 ± 0.82	25.25 ± 0.50	24.75± 0.50
Protein	22.70 ± 2.14	19.64 ± 0.41	19.52± 0.35	21.84 ± 0.70	20.22± 0.81
Fat	1.89 ± 0.85	3.59 ± 0.51	3.37 ± 0.52	2.29 ± 0.27	3.49 ± 0.46
Ash	1.17 ± 0.14	1.02 ± 0.25	1.11 ± 0.07	1.12 ± 0.10	1.04 ± 0.05

Means ± SEM Mean ± standard error of the mean

3.5. pH

As shown in table 5, the frozen meat pH was 5.67±0.18. The heterogeneity of the collected values allowed us to classify the meats into: PSE (Pale, Soft, Exudative) with pH <5,5 (13%); DFD (Dark, firm, Dry) with pH ≥ 5.8 (18%); and

RFN (Red, Firm, Non-exudative) with intermediate pH values between 5.5 and 5.8 (69%) (Figure 3).

Table 5: Averages pH measurements

	Neck	Blade bolar	Brisket	Blade oyster	FQ/HQ Shin-Shank	Mean ± SEM
pH	5.71 ± 0.12	5.38 ± 0.14	5.67 ± 0.16	5.67 ± 0.26	5.74 ± 0.12	5.67 ± 0.18

Means ± SEM Mean ± standard error of the mean

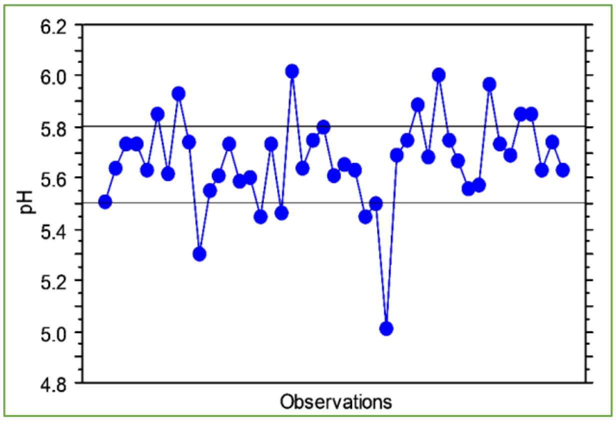

Figure 3: Proportions of the different categories of meat according to the pH

PSE (pH <5.5): Pale, Soft, Exudative; RFN (pH between 5,5 et 5,8): Red, Firm, Non-exudative; DFD (pH ≥ 5,8): Dark, Firm, Dry.

4. DISCUSSION

The most abundant chemical in meat is water, followed by protein then fat. Carbohydrates, minerals, and vitamins occur on much smaller amounts [3]. In the present study, we assessed the major chemical composition of Brazilian frozen beef imported into Algeria. The changes, observed on fat content in the analyzed meat, were in line with those previously reported [12-14]. It has been suggested that different factors may affect fat content in meat among different pieces such as: breed, production system considered, and for the same animal, according to the piece recovered (i.e. according to the muscle (s) that constitute it) [15-17].

Regarding the protein content, the obtained values agree with those obtained by Normand *et al.* [3], showing a relatively stable protein content of ruminant meat: about 20g/100 fresh weight, irrespective of muscle, animal type, racial type, or diet. The neck and the blade oyster contained more proteins than the other pieces, which contain lower fat rates (Table 2). Figure 2 highlights those data, where we reported a narrow inversely proportional relationship (R^2=0.745) between the two constituents. This foodstuff, therefore, represents a fairly stable water content. Similar values were obtained by Clinquart *et al.* [18]. The observed variations in water content may be due to various factors, such as the age of the animal, although we did not obtain precise data on the age of the slaughtered cattle that constitute the origin of our meat. Meat from young cattle are with high levels of water than from young adults [19,20].

Concerning ash content in analyzed meat, the sources of variation are largely unknown, although dietary supplements in minerals constitute the main factor of variation [3]. Furthermore, this content does not exceed 1-2 g/100 g [18-20].

The pH values recorded are considered optimal [3,18,21]. The high pH values observed in the analyzed pieces may result from insufficiently acidified meat. Acidification of the post-mortem muscle stops while the pH is still high. The origin of this issue might result in the reduction of glycogen stored in muscles just before slaughter [22]. Factors that are triggered are primarily related to pre-slaughter conditions for prolonged diets or physical expenditures related to grouping of animals. Truckload, transport, slaughterhouse waiting time, and emotional disturbances (stress, fear, pain, etc.) just before death, are factors to consider, all of which can lead to the consumption of the animal and the phenomenon "high pH" [18]. Furthermore, it should be noticed that the period between slaughtering animals, preparing meat (cutting, trimming, deboning, etc.), and freezing is occasionally insufficient for the meat to reach the desired pH.

Unlike the previous ones, PSE meats are labeled with a lower pH and are generally caused by too rapid drop in pH. They are found mostly in beef calves, but unfortunately, we did not have precise data on the type of animals slaughtered. A study of Mœvi [11] on 100 issues carcasses, to determine the probability of different muscles to be at high pH, showed that the blade bolar is rarely affected (<20 cases/100); the neck is often affected (45 to 75 cases/100); the blade oyster and the shin-shank are very often affected (>75 cases/100). The situation of the brisket was not mentioned in that document.

The most obvious limitation of the study is the undetermined age of investigated animals from which meat was obtained. Microbiological analysis is welcome in further studies.

5. CONCLUSION

Physicochemical analyses revealed water and ash contents in variable quantities from which the levels were particularly stable. Lipid contents have values characterizing lean meats. However, the protein fraction was acceptable overall and in the various analyzed pieces. As for pH, the obtained values showed a stability. It is true that freezing is one of the best methods of preserving meat of beef, but it cannot be considered as the best method for preserving mainly for long periods. Since meat is not an inert substance, during their conservation, it undergoes several physicochemical changes.

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