CARPATHIAN JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

journal homepage: **http://chimie-biologie.ubm.ro/carpathian_journal/index.html**

PHYSICOCHEMICAL CHARACTERISTICS, FATTY ACID COMPOSITION, AND FUNCTIONAL PROPERTIES OF THE TRADITIONAL SALTED DRIED MEAT OF *CAMELUS DROMEDARIUS* FROM ALGERIAN EASTERN SAHARA: "EL KADID"

Amina Bouchefra[1,2*], Tayeb Idoui[1,2], Chiara Montanari[3]

[1]*Laboratory of Biotechnology, Environment and Health, University Mohamed Seddik Benyahia of Jijel,Ouled Aissa City, 18000 Algeria.*
[2]*Department of Applied Microbiology and Food Sciences, University Mohamed Seddik Benyahia of Jijel,Ouled Aissa City, 18000 Algeria.*
[3]*Centro Interdipartimentale di Ricerca Industriale Agroalimentare Universitàdegli Studi di Bologna Via Quinto Bucci 336 47521 Cesena (FC), Italy.*
** aminabouchefra1@yahoo.fr*

https://doi.org/10.34302/crpjfst/2019.11.3.4

Article history:
Received:
2 January 2019
Accepted:
28 May 2019

Keywords:
Salted-dried meat;
Physicochemical properties;
Camelus dromedaries;
El Kadid;
Functional properties.

ABSTRACT

This is the first report describing physicochemical characteristics, fatty acid composition, and functional properties of traditional salted dried meat *El Kadid* produced from *Camelus dromedarius*. The samples were prepared according to the traditional Saharan method. The pH values ranged from 5.01±0.01 to 5.97±0.06; water activity ranged from 0.684±0.003 to 0.689±0.002; ash content ranged from 2.25±0.08 to 2.85±0.02%; moisture level was < 1%, and dry matter content exceeded 99%. The acid index, peroxide index, and acidity were in the range of 13.76 ± 0.14 to 20.66 ± 0.12 mg $KOHg^{-1}$, 0.45 ± 0.03 to1.0 $meqkg^{-1}$, and 0.16 ± 0.01 to 1.80 ± 0.02%, respectively. Protein, fat, and salt content were 19.73–22.52%, 3.17–7.14%, and 23.37–57.86% respectively. 19 fatty acids were identified, The oleic acid C18:1 was the predominant monounsaturated fatty acid (1.80%–59.98%) and palmitic acid C16:0 was the major SFA (25.98%–48.31%).regarding functional properties, Water Absorption Capacity and Oil Absorption Capacity values varied between 2.42 ± 0.03 -5.30 ± 0.05 and10.34 ± 0.05 to 13.34 ± 0.05 mLg^{-1}respectively.

1.Introduction

The dromedary camel (*Camelus dromedarius*) is an animal whose services to the human kind can easily be underestimated even though its adaptability to the harsh climate of the desert is widely known. This (the dromedary or one-hump camel) is the most populous camel species in the world. The dromedary camel has unique physiological characteristics, including a high tolerance to temperature changes, solar radiation, water scarcity, rough topography, and poor vegetation (Suliman et al., 2016). Camel meat is an excellent source of many nutrients, especially amino acids, B vitamins, iron, and zinc (Geay et al., 2001). The proximate composition of camel meat is similar to meats from other species, witham inverse relationship between the moisture and protein and fat content. Besides from its importance in determining the nutritional value of the meat, the proximate composition is also an indicator of meat functionality (Kadim et al., 2006) as protein and fat content determine its manufacturing quality. Because of its potential high dietetic quality, camel meat might be particularly beneficial for human consumers

(Kadim et al., 2008). Fat is a vital nutrient with many functions in the human body (e.g., energy provider, carrier of fat-soluble vitamins, component of cell membranes, basic substance of hormones and second messengers). It is also important for sensory characteristics of food (e.g., flavor and texture), and therefore plays an essential role in meat quality. However, the dietary fat intake is also associated with health problems (Schmid,2011). Not only the ingested amounts but also the nature of the fatty acids (saturated vs. unsaturated fatty acids, n-6/n-3ratio, etc.) is pertinent to the health of human beings (Dilzer and Park, 2012).Different types of meat products are on offer, varying in their methods of preparation and preservation. *El Kadid* is a sun-dried product commonly found in North Africa and the Middle East. It has been consumed in Arabia since pre-Islamic times (Bekhit and Farouk,2013a). Large amounts of meat products are customarily prepared for the Eid-ul-Adha festival in Algeria; the excess has to be preserved for later consumption. Raw meat is prone to microbial contamination during its production and handling, which might result in serious illnesses. Therefore, it is crucial to preserve it promptly and in an appropriate manner to prevent spoilage. In Algeria, the most common name for dried meat is *El Kadid*; it's often prepared by the Northerners using sheep and cow meat and by Southerners, using camel meat. Drying is one of the oldest methods of meat preservation. The method reduces the water content to such an extent that the bacteria cannot grow on such products. There are some reports on the quality of meat obtained by drying, curing, or freezing in the developed countries. Unfortunately, there is no data on the quality of dried salted camel meat, *El Kadid*, produced in Algeria. The current study was conducted to evaluate the effect of traditional methods (sun drying and salting) on the nutritional and functional quality of this local camel meat product.

2. Materials and methods

2.1.Salted dried meat Samples

Nine fresh samples of camel meat were collected from different animals in Oued Souf region of Algeria and parts of thigh were used. El Kadid was prepared using a traditional method. After slaughtering, the muscles of thigh were washed under running water and μthen cut into strips of thickness and size (about 1 cm wide and 10-20 cm long). In a bowl, afterwards, other ingredients such as salt (6.0 g salt/100g of meat), pepper and olive oil were added to the strips of meat and then left overnight to macerate at 4 °C. Then we proceed with the drying phase, in which the strips of meat were left to dry on ropes under the sun between 9 am and 15 am every day, under a temperature of 30°C and humidity percentage of 67% for a period of about 10 days and periodically turned, in order to obtain a uniform drying of the product. The drying phase ends when the meat reaches a brown color and the right fibrous appearance. Finally, the strips of meat were cut into 2-3 cm long pieces and placed inside a sealed jar, stored at room temperature.

2.2. Physicochemical characteristics

2.2.1. pH

pH was determined using a pH-meter (HANNA HI 2210-Romania). The samples (5 g of dried salted meat each) were homogenized in 50 mL of distilled water. Suspension was filtered and the titration was performed using 0.1N hydrochloric acid solution (Carlo ERBA, Val de Reuil, France), with five drops of phenolphthalein (Riedel-de Haen, Germany) as an indicator (AOAC, 1995)**.**

2.2.2. Water activity

The value of the water activity (a_w) was determined using the Aqualab CX3-TE instrument (Labo-Scientifica, Parma, Italy), by placing appropriate quantities of sample into the spacecraft appropriate.

2.2.3. Salt content

Salt content was analyzed following the method published in Application Bulletin No. 130/2. Ten g of dried salted meat was

homogenized in 190 mL of distilled water. Two mL of 2M potassium chromate solution (Fluka, Almaty, Kazakhstan) was added to 50 mL of the mixture. The titration was performed using silver nitrate solution (0.1M) (Biochem Chemopharma, Montreal, Canada).

2.2.4. Moisture, dry matter, and ash content

Moisture, dry matter, and ash content were measured following the AOAC (2000) methods. Two-g *El Kadid* samples were dried at 105± 1 °C. Sample weight was monitored until its stabilization. Dry matter content was obtained after drying in the oven at 105°C ± 1°C. Then, the samples were transferred to a Thermolyne F48010-33 Muffle Furnace (Cole-Parmer,VernonHills,USA) and heated at 550°C to complete the combustion of carbon. Once the combustion residue became white, the sample was weighed to obtain the ash matter content.

2.2.5. Peroxide index

For the determination of peroxide index, one g of *El Kadid* sample was dissolved in acetic acid (Sigma-Aldrich)-chloroform (Biochem) solution (3:2 v/v). Then, the solution was added to 1 mL of saturated potassium iodide (Riedel-de Haen).The mixture was titrated with sodium thiosulfate solution (0.01N) (Enthone-OMI, Spain) in the presence of starch as an indicator. For the determination of acid index, two-g *El Kadid*sample was dissolved in diethylether-ethanol mixture (1:1 v/v) (Prolabo, Riedel-deHaen). The solution was titrated with 0.05M potassium hydroxide (Riedel-deHaen) in methanol (Biochem) using phenolphthalein as an indicator.

2.2.6. Fat content

Fat content was determined according to AOAC (2000), using anEV-16 Soxhlet extractor (Gerhardt, Bonn, Germany).The sample remaining after moisture determination was transferred to the fat extraction thimble, which was loaded into the chamber of the extractor. One hundred and fifty mL of petroleum ether (Sigma-Aldrich, Taufkirchen Germany) was added to the distillation flask of the device. The samples were extracted for 8 h over a water bath at 80°C. At the end of the extraction period, the thimble was removed from the device and most of the petroleum ether in the flask was distilled off. The petroleum ether was evaporated on steam bath at low temperature and was then dried at 100°C for 1 hour, cooled and weighed.

2.2.7. Protein content

Protein content was determined according to the AOAC method (2000). A 2 g sample of *El Kadid* was placed in a 250 mL Kjeldahl flask (Gerhardt) with 25 mL of concentrated sulfuric acid (Biochem Chemopharma, Montreal, Canada). The contents of the Kjeldahl flask were heated in the digestion chamber until the solution became clear. Then, the solution was cooled and diluted to 100 mL with distilled water. An aliquot of 5mL was taken for distillation. Forty mL of 40% sodium hydroxide (Biochem Chemopharma, Montreal, Quebec) was added to the distillation flask. The resulting ammonia was distilled into boric acid solution (Fluka chemicals, USA) until the color of the solution changed from bluish purple to bluish green. The contents of the boric-acid flask were titrated using the standard hydrochloric acid solution (0.01N) until the blue color disappeared.

2.3. Fatty acid profile

Fatty acid profile was determined following the method described in Arrete du 5 mai 1986 of the French Ministry of Commerce. *El Kadid* samples (0.2 g) were extracted by adding 4 mL of heptane (Prolabo BDH, France), and 0.1 mL of potassium hydroxide solution in methanol (2N) was added to the extract. The solution was stirred vigorously using a vortex (Stuart, UK) for 10 s. The solution was put to rest during 10 min to separate the clear layer of fatty acids from the cloudy aqueous layer. The upper, fatty acid layer was collected. The fattyacid solution was injected into a GCMS-QP2010 gas chromatograph (Shimadzu, Kyoto, Japan). We employed anon-polar capillary column SE-30 with a diameter of 0.25µm, temperature 180°C (or a gradient from 170 to 200 °C), FID detector, heptane as a solvent, dimethylpolysiloxane as

SE-30stationary phase, and helium as the mobile phase.

2.4. Mineral and heavy metal analysis

Mineral analysis was carried out according to the method of Faleye and Fagbohun (2012). Each ash sample was placed in1 mL of pure hydrochloric acid, and 10 mL of distilled water was added. The solution was heated for 5 min until complete dissolution, and then distilled water was added to the volume of 100 mL.The levels of lead, chromium, zinc, iron, copper manganese, and cadmium were examined using AA-6200 atomic absorption spectrophotometer (Shimadzu).

2.5. Functional properties

Foaming and emulsion capacity values were determined following the previously described methods (Yasamatsu et al.,1972). Hygroscopicity was obtained using the method described by Bhatty (1988). Five g of *El Kadid* sample was exposed to the temperature of 31°C and humidity of 64%. Hygroscopicity was expressed as an increase in the weight of samples (percent) after 48 h of exposure. Oil and water absorption capacity (OAC and WAC) were determined according to Beuchat (1977). Samples (1 g) were mixed with 10 mL of distilled water or oil for 30 sec, left at room temperature for 30 min, and centrifuged at 5000 × g for 30 min (using HettichEBA 20 centrifuge). The volume of the supernatant was measured in a 10-mL graduated cylinder. The density of water was assumed 1 g mL^{-1} and of oil, 0.911 g mL-1.

2.6. Statistical analysis

In our study the data analysis was performed with SPSS software (version 20.0) [SPSS Inc., France]. The results obtained for three replications were subjected to analysis of variance (ANOVA: Analysis of Variance at a Factor). At $P < 0.05$, the difference between samples was considered significant.

3.Results and discussions

3.1. Physicochemical characteristics of *El Kadid*

The acidity, pH, water activity, peroxide, and acid indices are presented in Table 1. We found that pH values varied between 5.01± 0.01 and 5.97 ± 0.06($P<0.05$). Kadim et al. (2006) have reported that pH of fresh camel meat ranges between 5.7 and 6.0. The pH of *El Kadid* after salting and drying process is due to the alkalinization caused by the addition of salt. Water activity was in the range of 0.684 ±0.003 to0.689± 0.002 ($P>0.05$).Acid values of *El Kadid* samples ranged from 13.76± 0.14 to 20.66± 0.12 mg KOH g^{-1} of meat ($P>0.05$). These high acid values could be attributed to lipolysis by lipolytic microorganisms or to lipase activity naturally present in meat. The examination of the acid values has been used to assess the degree of fat alteration (Amon et al. 2009). The peroxide index values varied from 0.45± 0.03 to 1.00 meq kg^{-1} of meat ($P<0.05$). The polyunsaturated fatty acids are very sensitive to oxidation and create peroxides. Susceptibility of lipid peroxidation in food depends on the lipid composition, the presence of prooxidants and antioxidants, oxygen levels, temperature, light and processing methods. PUFA-rich foods are more susceptible for lipid oxidation. Likewise, presence of prooxidants such as redox active metals (Fe, Cu) and hemeproteins, exposure to high oxygen levels and high temperature may accelerate oxidation process. Lipid oxidation often brings problems in food processing and storage. Oxidation of PUFAs produces a complex mixture of volatile secondary oxidation products, and these cause particularly objectionable off-flavors, lipid oxidation may reduce the nutritional value by causing the destruction of essential fatty acids and the lipid-soluble vitamins A, D, E, and K as well as the decrease in caloric content. Free radicals and metabolites formed during oxidation may exert adverse effects on human health (Tao,2015). The low levels of this type of fatty acids in our samples justify the obtained peroxide index values.

Moisture, ash, dry matter, fat, protein, and salt content are shown in Table 2. The level of moisture in *El Kadid* samples varied between 0.28 ± 0.09 and 0.84 ± 0.02% (P <0.05). Ash content was in the range of 2.25 ±0.08 to2.85± 0.02% (P <0.05). The samples contained 99% of dry matter (P <0.05). The moisture content of fresh camel meat is approximately 73% (Kadim and Mahgoub, 2013). The *El Kadid* contains very little moisture (< 1%) due to the drying process (evaporation) and salting, reducing the water level by salting out. This traditional salting–drying method increases the concentration of protein and other nutrients. There was an inverse relationship between the dry matter and moisture content. The ash content in fresh camel meat is in the range of 0.75–1.38%; this is lower than in our case. Some reports suggested that the ash content varies depending on the types of the muscle and meat cut (Babiker and Yousif, 1990; Dawood and Alkanhal, 1995; Gheisari et al., 2009) and the age of the animal (Gheisari et al., 2009).Our results showed a change in ash content caused by salt and condiments used in the preparation of *El Kadid*.Our results showed the fat content between 3.17 and7.14% (P <0.05),while the fat content of fresh camel meat ranges from 1.4 to 10.6% (Bekhit and Farouk ,2013b).The observed decrease in fat content was due to the oxidation of fat during sun drying. Slight differences in the fat content have been reported for different cuts and muscle types, with a significant variation. Clearly, the age of the animal has a strong effect on the amount of stored fat; old animals contain more fat than the young individuals (Elgasim and Alkanhal, 1992; Dawood and Alkanhal 1995; Kadim et al., 2006; Gheisari et al., 2009). It is important to note that camel meat contains less fat than beef, lamb, or goat meat and has only slightly higher fat content than ostrich meat. This makes the camel meat a healthy option to be used in special diets (Bekhit and Farouk, 2013b). Protein content ranged from 19.73 to 22.52% in *El Kadid* samples (P <0.05). Fresh camel meat contains 18.2–23.7% of protein and genetic and dietary factors might have a slight effect (Dawood and Alkanhal, 1995; Kadim et al.,2006).Based on the obtained results, we can conclude that *El Kadid* is a good source of protein with a high biological value. Moreover, salt content varied between 23.37 ± 0.04 and 57.86 ± 0.05 % (P< 0.05).In food industry, extending the shelf life of food products is often achieved by salting. This leads to desorption of large amounts of water and a substantial increase in the osmotic pressure, which lowers the water activity and thus inhibits the growth of microorganisms (Berkel et al., 2004).

.**Table 1.** Acidity, pH, water activity, peroxide and acid index of *El kadid* samples.

Sample	Acidity %	pH	Peroxide index Meqg^{-1}	Water activity	Acid index mg KOHg^{-1}
DCM1	0.81±0.09^{c}	5.07±0.05^{a}	0.75±0.00^{b}	0.689 ± 0.002^{d}	16.84±0.42^{b}
DCM2	0.99±0.00^{c}	5.21±0.07^{a}	0.50±0.00^{b}	0.689 ± 0.002^{d}	18.53±0.42^{b}
DCM3	1.07±0.20^{c}	5.01±0.01^{a}	0.70±0.00^{b}	0.688± 0.001^{d}	18.51±0.22^{b}
DCM4	1.80±0.02^{c}	5.85±0.03^{a}	0.45±0.03^{b}	0.688± 0.002^{d}	19.07±0.30^{c}
DCM5	0.90±0.00^{c}	5.97±0.06^{a}	0.47±0.07^{b}	0.684± 0.003^{d}	20.66±0.12^{c}
DCM6	0.48±0.02^{c}	5.36±0.01^{a}	1.00±0.00^{b}	0.685± 0.004^{d}	16.17±0.28^{b}
DCM7	0.43±0.02^{c}	5.65±0.01^{a}	0.50±0.00^{b}	0.685± 0.001^{d}	13.76±0.14^{a}
DCM8	0.16±0.01^{c}	5.75±0.02^{a}	0.80±0.00^{b}	0.686± 0.003^{d}	18.42±0.29^{b}
DCM9	0.21±0.01^{c}	5.78±0.01^{a}	0.80±0.05^{b}	0.686± 0.002^{d}	17.43±0.42^{b}

Results are expressed as means ± standard deviation of three measurements.
$^{a-d}$Means followed by a different letter in the same column aresignificantly different P <0.05

Table 2. Dry, ash matter, moisture, fat, protein and salt content of *El kadid*samples (%).

Sample	Dry	Ash	Moisture	Protein	Fat	Salt
DCM1	99.00±0.00^{a}	2.25±0.08^{b}	0.84±0.02^{d}	19.73±0.00^{c}	7.14±0.00^{e}	50.25±0.05^{f}
DCM2	99.00±0.01^{a}	2.44±0.00^{b}	0.82±0.04^{d}	22.08±0.00^{c}	3.80±0.04^{e}	44.41±0.03^{f}
DCM3	99.45±0.05^{a}	2.34±0.00^{b}	0.54±0.03^{d}	21.00±0.01^{c}	4.52±0.03^{e}	39.72±0.05^{f}
DCM4	99.60±0.03^{a}	2.56±0.01^{b}	0.42±0.05^{d}	20.83±0.03^{c}	5.00±0.05^{e}	37.40±0.03^{f}
DCM5	99.50±0.01^{a}	2.85±0.02^{b}	0.45±0.02^{d}	20.16±0.02^{c}	6.34±0.02^{e}	23.37±0.04^{f}
DCM6	99.60±0.00^{a}	2.65±0.08^{b}	0.31±0.04^{d}	22.52±0.00^{c}	3.17±0.00^{e}	57.86±0.05^{f}
DCM7	99.49±0.03^{a}	2.50±0.00^{b}	0.28±0.09^{d}	21.56±0.00^{c}	4.41±0.00^{e}	45.58±0.07^{f}
DCM8	99.77±0.03^{a}	2.82±0.01^{b}	0.32±0.01^{d}	20.75±0.00^{c}	5.01±0.00^{e}	52.60±0.08^{f}
DCM9	99.65±0.05^{a}	2.32±0.05^{b}	0.40±0.01^{d}	19.94±0.00^{c}	6.91±0.00^{e}	50.14±0.09^{f}

Results are expressed as means ± standard deviation of three measurements.
$^{a-f}$Means followed by a different letter in the same column are significantly different P <0.05.

3.2. Mineral and heavy metals analysis

Table 3. shows the content of minerals and heavy metals in our samples. *El Kadid* contains zinc (0.3 ± 0.06; *P*<0.05), iron (0.99 ± 0.20; *P*>0.05), manganese (0.03 ± 0.13; *P*<0.05), and copper (0.03 ppm; *P*<0.05). The animal species, age, and the environment (Bekhit, and Farouk, 2013b) affect the mineral composition of meat. Zinc is an activator of several enzyme systems; it is important in cell division and differentiation mechanisms and in the metabolism of nucleic acids. It is also involved in the production, storage, and secretion of hormones (Mgbabu, 2011).Manganese is a trace element that is essential in the diet of all animals. It is found in all body tissues; it is necessary in many ubiquitous enzymatic reactions, including synthesis of amino acids, lipids, proteins, and carbohydrates. While this metal can be inhaled from the air, the diet is normally a far better source of manganese. Because of homeostatic systems regulating the absorption and excretion of manganese, its levels in the tissues are usually very stable, regardless of intake levels. However, it can accumulate in certain brain regions following excessive exposure, and manganese-induced neurotoxicity can ensue. Copper is a trace element found in all tissues; it is required for cellular respiration, peptide amidation, neurotransmitter biosynthesis, pigment formation, and maintaining the connective tissue strength. Copper is a cofactor for numerous enzymes and plays an important role in the development of central nervous system; low concentrations of copper may result in incomplete development, whereas excess copper maybe harmful. It can be involved in free radical production, via the Haber-Weiss reaction, resulting in mitochondrial damage, DNA breakage, and neuronal injury (Desai and Kaler, 2008). Iron is a component of several metalloproteins and plays a crucial role in vital biochemical activities, such as oxygen sensing and transport, electron transfer, and catalysis. Iron is thus indispensable to life. The biological functions of iron exploit its chemical properties, e.g., its capacity to form a variety of coordination complexes with organic ligands in a dynamic and flexible mode. One of its notable properties is its favorable redox potential; it can switch between the ferrous, Fe (II), and ferric, Fe(III), states (+772 mV at neutral pH) (Papanikolaou and Pantopoulos, 2005). The meat is an important source of iron; lack of iron causes the most common nutritional deficiency worldwide (Warriss,2000). However, the analysis also revealed the presence of heavy metals, lead at 0.11±0.02 (*P*<0.05), chromium, 0.16±0.05 (*P*>0.05), and cadmium, at 0.11 ppm (*P*>0.05) in the samples of *El Kadid*. The heavy metals might have been be absorbed directly by the animal.

Table 3. Minerals and heavy metals composition of *El kadid* samples (ppm)

Sample	DCM1	DCM2	DCM3	DCM4	DCM5	DCM6	DCM7	DCM8	DCM9
Zinc	0.46 ±0.11[a]	0.16 ±0.00[a]	ND	ND	ND	0.36± 0.06 [a]	0.18 ±0.00 [a]	0.21 ±0.05 [a]	0.46 ±0.14 [a]
Iron	1.37 ±0.33 [a]	1.10± 0.12 [a]	ND	ND	ND	0.69± 0.06[b]	0.72 ±0.12[b]	1.14 ±0.23 [a]	0.94 ±0.37 [a]
Manganese	0.02 ±0.01[c]	0.02 ±0.01[c]	ND	ND	ND	0.04 ±0.01 [c]	0.04±0.00 [c]	0.06 ±0.04 [c]	0.05± 0.03 [c]
Copper	0.04± 0.00[d]	0.03± 0.00 d	ND	ND	ND	0.03± 0.00 [d]	0.06± 0.00 [d]	0.04± 0.02 [d]	0.03± 0.01 [d]
Plumb	0.10± 0.01[e]	0.13±.0.03 [e]	ND	ND	ND	0.13 ±0.04 [e]	0.10± 0.02 [e]	0.10 ±0.00 [e]	0.10 ±0.03 [e]
Chromium	0.03± 0.00[f]	0.02 ±0.01 [f]	ND	ND	ND	0.23± 0.16[d]	0.07 ±0.04 [f]	0.29 ±0.09 [d]	0.32± 0.01 [d]
Cadmium	0.16± 0.00[f]	0.46± 0.00[f]	ND	ND	ND	0.02± 0.00[g]	0.02± 0.00 [g]	0.02 ±0.00 [g]	0.02± 0.01 [g]

Results are expressed as means ± standard deviation of three measurements.
[a-g]Means followed by a different letter in the same row are significantly different P <0.05.
ND: not determined

3.3. Fatty acid profil

The fatty acid composition of *El Kadid*has not been documented before. Most of the available data focuses on the composition of the hump (Kadim et al., 2002).The saturated fatty acid (SFA) ratio total fatty acids in the camel meat are within the range of total SFA reported for beef(43–52%) and lamb (46–54%) (Aro et al. 1998).In our samples, 19 fatty acids were identified (Table 4).Extensive characterization of the fatty acids of camel meat has been published by Rawdah et al. (1994), who identified 22 fatty acids. We showed important differences between fatty acid compositions in *El Kadid* samples. The traditional salted and dried camel meat contained a high percentage of SFA and palmitic acid C16:0 was the major SFA (25.98±0.05%–48.31±0.01%), followed by stearic acid C18:0 (11.57±0.03%–32.35±0.01%) and margaric acid C17:0 (0.90±0.01%–3.35±0.02%).The oleic acid C18:1 was the predominant monounsaturated fatty acid (1.80±0.03%–59.98±0.02%) followed by palmitoleic acid C16:1 (3.46±0.02%–7.65±0.01%). The fatty acid composition of meat and fat of *Camelus dromedarius* showed that the major saturated and monounsaturated fatty acids are C16:0 (25.98%; 30.29%; and 28.50%) and C18:1(18.93%; 32.01%; and 33.50%, respectively). Although the published reports agree on the percentage of total SFAs (51.5–53%), different percentages of monounsaturated fatty acids have been reported (29.9% and 41.4%) (Rawdah et al., 1994; and Kadim et al., 2011). The composition of fatty acids is affected by the diet, the age of the animal and the low volume of olive oil added to the preparation. Olive oils an example of a natural functional food ingredients. It contains a lot of antioxidants, it is dominated by monounsaturated fatty acids, it is characterized by low contain of saturated fatty acids, and contains essential fatty acids with a balanced ratio between ω-6 and ω-3 (oleic acid and linoleic acid). In all published studies, olive oil contains low percentage (8-14%) of saturated fatty acids (SFA). Unsaturated fatty acids are an important factor by which the olive oil is distinguished from other fats (65-83). The most common monounsaturated fatty acid in olive oil is oleic acid (18:1 n-9); it has a great biological nutritional value and is easily digestible. That's why olive oil is a representative of the oleic acid oil group (Šarolić et al., 2014). The highest percentage of unsaturated fatty acids and the lowest percentage of SFAs are found in the animals less than 1 year old, whereas the opposite trend is observed in animals in the 1–3year age group (Kadim et al., 2002). As shown in Table 4, other fatty acids were also detected, such as iso-margaric acid, lauric acid,

heneicosanoic acid, carboceric acid, pentadecanoic acid, myristic acid, 14-pentadecanoic acid, 14-hexadecanoic acid, 17-octadecanoic acid, 7-hexadecenoic acid, 2-hydroxy-hexadecanoic acid, vaccenic acid, 10-octadecenoic acid, and 11,14-eicosadienoic acid.

Table 4. Fatty acid profiles of *El kadid* samples (% of each peak on total peak area).

Fattyacids	DCM1	DCM2	DCM3	DCM4	DCM5	DCM6	DCM7	DCM8	DCM9
Palmiticacid	25.98± 0.05^{a}	27.47± 0.06^{a}	32.57± 0.02^{b}	-	37.62± 0.05^{b}	48.31± 0.01^{c}	43.01± 0.02^{d}	40.65± 0.01^{d}	43.80± 0.02^{d}
Margaricacid	-	-	0.90± 0.01^{a}	3.35± 0.02^{b}	0.69± 0.03^{a}	0.72± 0.01^{a}	1.90± 0.02^{c}	-	1.69± 0.04^{c}
Isomargaricacid	-	-	-	-	-	2.73± 0.03^{a}	0.76± 0.03^{b}	3.01± 0.08^{d}	1.77± 0.05^{c}
Stearicacid	11.57± 0.03a	-	22.51± 0.01^{d}	32.35± 0.01^{d}	11.75± 0.01^{a}	13.00± 0.03^{b}	13.68± 0.01^{c}	22.80± 0.06^{e}	19.50± 0.02^{f}
Lauricacid	-	-	-	-	0.75± 0.02^{a}	-	1.04± 0.04^{b}	-	1.30± 0.05^{c}
Heneicosanoicacid	-	-	1.74± 0.03^{a}	-	-	-	-	1.23± 0.06^{b}	1.64± 0.01^{a}
Carbocericacid	-	-	-	-	-	-	-	1.36± 0.04	-
Pentadecanoicacid	-	-	-	-	2.91± 0.06^{a}	2.05± 0.02^{b}	3.41± 0.01^{c}	-	0.95± 0.02^{d}
Myristicacid	-	-	-		1.78±	-		-	1.81±
14-Pentadecanoic acid	-	-	1.03± 0.01^{a}	1.50± 0.03^{b}	-	0.56± 0.05^{c}	0.67± 0.02^{c}	-	0.60± 0.05^{c}
14-Hexadecanoic acid	-	-	0.75± 0.01^{a}	2.40± 0.01^{b}	-	1.63± 0.03^{c}	-	-	-
17-Octadecanoic acid	-	-	-	-	-	1.90± 0.02	-	-	-
7-Hexadecenoic acid	-	-	-	-	-	-	0.73± 0.03^{a}	-	0.46± 0.04^{b}
2-Hydroxy-hexadecanoic acid	-	-	-	-	-	-	-	0.82± 0.01	-
Palmitoleicacid	-	-	4.25± 0.06^{a}	3.46± 0.02^{b}	7.65± 0.01^{c}	5.27± 0.01^{d}	7.56± 0.01^{e}	-	7.56± 0.02^{e}
Oleicacid	59.98± 0.02^{a}	41.02± 0.02^{b}	27.27± 0.05^{c}	37.79± 0.02^{d}	17.29± 0.01^{e}	23.51± 0.02^{f}	22.40± 0.02^{g}	25.79± 0.01^{h}	1.80±0. 03^{i}
Vaccenicacid	-	-	-	-	-	-	-	-	1.07± 0.02
10-Octadecenoic acid	-	-	-	-	-	-	-	2.73± 0.01	-
11,14-Eicosadienoic acid	-	-	-	-	-	-	-	-	0.44± 0.02

Results are expressed as means ± standard deviation of three measurements.
$^{a-i}$Means followed by a different letter in the same row are significantly different P <0.05.

3.4. Functional properties

The functional properties are shown in Table 5. Our results revealed that the Water Absorption Capacity (WAC) values varied between 2.42± 0.03 and 5.30 ± 0.05 mLg^{-1} (P< 0.05). This is probably due to the lower carbohydrate content and reduced space in the structure due to salting and sun drying. The

WAC of proteins is a criterion used to determine the quality of food texture, in particular for meat products. The production yield and sensory qualities depend on the WAC (Selmane,2010). Microscopic investigation of kilish (meat product) has shown that the size and shape of the starch granules as well as the distribution of the protein clusters has an important effect on the WAC (Muir et al., 2000). The OAC values ranged from 10.34 ± 0.05 to 13.34 ± 0.05 mLg^{-1} (P <0.05). These values could be explained by the reduced fat content, resulting from lipid oxidation during sun drying. Our results suggest that hygroscopic properties of the protein in *El Kadid* remained almost unchanged. This agrees with the results of Hayta et al. (2002), who have reported that the OAC of any food material depends on the degree of hygroscopicity of the system. Here, the hygroscopicity of the samples varied between 1.58 ± 0.01 and 3.43 ± 0.03 % (P<0.05). These results may be due to the prolonged exposure to the sun. The hygroscopicity is an important parameter in food formulation; it is affected by the polarity, texture, size, and microstructure of the protein particles (Kinsella, 1979). Moreover, the emulsion and foaming capacity values (P<0.05) of *El Kadid* samples ranged between 3.36 ±0.04%and5.34± 0.03% and between 6.20 ± 0.02% and8.95 ± 0.09%, respectively. These foaming capacity values are due to a reduced fat content and high protein level. The foaming capacity of a substance depends on the surface-active properties of the proteins involved. Kinsella (1979) has found that some food proteins can form foams; their capacity to foam and retain stable foams depends on the type of protein, degree of denaturation, pH, temperature, and processing method. Emulsion capacity values were due to interactions of the proteins with other components of the samples.

Table 5. Functional properties of *El kadid* samples.

Sample	Hygroscopicity %	WAC mLg^{-1}	OAC mLg^{-1}	FC %	EC %
DCM1	2.20±0.01^{b}	4.50±0.05^{a}	10.34±0.05^{c}	6.25±0.03^{d}	3.36±0.06^{e}
DCM2	1.86±0.01^{b}	4.50±0.05^{a}	13.25±0.02^{c}	8.62±0.01^{d}	5.33±0.03^{e}
DCM3	2.32±0.03^{b}	3.50±0.02^{a}	12.20±0.01^{c}	7.95±0.01^{d}	4.45±0.01^{e}
DCM4	3.34±0.04^{b}	4.35±0.01^{a}	12.03±0.02^{c}	7.62±0.05^{d}	4.35±0.03^{e}
DCM5	1.58±0.01^{b}	2.42±0.03^{a}	11.36±0.01^{c}	7.22±0.02^{d}	4.15±0.05^{e}
DCM6	2.32±0.02^{b}	4.30±0.01^{a}	13.34±0.05^{c}	8.95±0.09^{d}	5.34±0.03^{e}
DCM7	2.06±0.01^{b}	4.09±0.02^{a}	12.86±0.04^{c}	8.21±0.07^{d}	4.56±0.02^{e}
DCM8	3.43±0.03^{b}	5.30±0.05^{a}	11.68±0.01^{c}	7.32±0.02^{d}	4.23±0.03^{e}
DCM9	2.56±0.02^{b}	4.80±0.04^{a}	10.50±0.05^{c}	6.20±0.02^{d}	3.36±0.04^{e}

Results are expressed as means ± standard deviation of three measurements.
$^{a-e}$Means followed by a different letter in the same column are significantly different P <0.05.

4. Conclusions

From the obtained results, we can conclude that important differences were found in physicochemical, fatty acids composition and functional properties of traditional salted-dried meat *El Kadid* produced from camel meat (*Camelus dromedarius).* Thus, the present study is expected to encourage more research in quality of traditional Algerian salted-dried meat.

5.References

Amon, R., AhipoDué, E., Kouadio, E.N.K., Koamé, L.P. (2009). Valeur nutritionnelle et caractérisation physicochimique de la matiere grasse de la chenille (Imbrasia oyemensis) séchée et vendue au marché d'Adjamé (Abidjan, Cote d'hivoire).

Journal of Animal and Plant Sciences,3,243-250.

AOAC (1995). Official Methods of Analysis. 15th ed. Association of Official Agricultural Chemits, Washington, DC.

AOAC (2000). Official Methods of Analysis. 17th ed. Association of Official Agricultural Chemits, Washington, DC.

Aro, A., Antoine, J.M., Pizzoferrato, L., Reykdal, O., Poppel, G. (1998). Tran's fatty acids in dairy and meat products from 14 European countries: the transfair study. *Journal Food Composition and Analysis*, 11, 150–160.

Application Bulletin No. 130/2 F. Titration of chloride with potentiometric indication. Interest in: General analytical laboratories, Metrohm., p, 5.

Arrêté du 5 mai 1986. of French Ministry of Commerce-the method of duck breasts analysis. Determining percentage of fatty acids.

Babiker, S.A.,Yousif, O.K. (1990). Chemical composition and quality of camel meat. *Meat Science,* 27,283–287.

Bekhit, A.E., Farouk, M.M. (2013a). Processed of Camel Meats. In: I.T. Kadim (Ed.), Camel meat and meat products. (pp. 186-201), London: CAB International.

Bekhit, A.E., Farouk, M.M. (2013b). Nutritive and Health Value of Camel Meat.In:I. Kadim (Ed.),Camel meat and meat products. (pp. 205-223), London: CAB International.

Berkel, M.V., Boogaard, V.D.B., Heijnen, C. (2004). Salting fish and meat:InThe Preservation of fish and meat, Agrodok Manual (12rd), AgromisaFondation, Wageningen ,(Chapter16).

Beuchat, L.R. (1977). Functional and electrophoretic characteristics of succinylated peanut flour protein. *Journal of Agricultural and Food Chemistry,* 25, 258-261.

Bhatty, R.S. (1988). Physico-Chemical and Functional properties of hull-less barley fractions. *Journal of General Chemestry,* 63, 31-35.

Dawood, A., Alkanhal, M.A. (1995). Nutrient composition of Najdi- Camel Meat. *Meat Science*, 39, 71–78.

Desai, V., Kaler, S.G. (2008). Role of copper in human neurological disorders[1–3]. *American Journal Clinical Nutrition* , 88(suppl),855S–8S.

Dilzer, A., Park, Y. (2012). Implication of conjugated linoleic acid (CLA) in human health. *Critical Review* of *Food Science Nutrition*, 52, 488–513.

Elgasim, E.A., Alkanhal, M.A. (1992). Proximate composition, amino acids and inorganic mineral content of Arabian Camel meat: comparative study. *Food Chemestry*, 45,1–4.

Faleye, O.S., Fagbohun, E.D. (2012). Effects of storage on the proximate, mineral Composition and mycoflora of "Tinco" dried meat sold in Oshodi market, lagos state, Nigeria. *Global Journal of Biochemestry and Biotechnology,* 1, 54-58.

Geay, Y., Bauchar, D., Hocquette, J.F., Culioli, J. (2001). Effect of nutritional factors on biochemical, structural and metabolic characteristics of muscles in ruminants, consequences on dietetic value and sensorial qualities of meat. *Reproduction of Nutritional Developement*,41,1–26.

Gheisari, H.R., Aminlari, M., Shekarforoush, S.S. (2009). A comparative study of the biochemical and functional properties of camel and cattle meat during frozen storage. *Veterinarski Archiv*,79,51–68.

Hayta, M., Alpslamand, M., Baysar, A. (2002). Effects of drying methods on functional properties of Tarhana: A wheat flouryoghunt mixture. *Journal of Food Science*, 67, 740- 744.

Kadim, I.T., Mahgoub, O., Al-Maqbaly, R.S., Annamalai, K., Al-Ajmi, D.S. (2002). Effects of age on fatty acid composition of the hump and abdomen depot fats of the Arabian camel (*Camelus dromedarius*). *Meat Science*, 62, 245–251.

Kadim, I.T., Mahgoub, O., Al-Marzooqi, W., Al-Zadgali ,S., Annamali, K., Mansour,

M.H. (2006). Effects of age on composition and quality of muscle *Longissimusthoracis*of the Omani Arabian Camel (*Camelus dromedarius*). *Meat Science,* 73, 619–625.

Kadim, I.T., Mahgoub, O., Purchas, R.W. (2008). A review of the growth and of the carcass and meat quality characteristics of the one-humped camel (*Camelus dromedaries*). *Meat Science,* 80, 555–569.

Kadim, I.T., Al-Ani, M.R., Al-Maqbaly, R.S., Mansour,M.H., Mahgoub, O., Johnson, E.H. (2011). Proximate, amino acid, fatty acid and mineral composition of raw and cooked camel (*Camelus dromedarius*) meat. *British Food Journal,* 113,482–493.

Kadim, I.T., Mahgoub, O. (2013). Structure and quality of camel meat. In I.T.Kadim (Ed.), Camel meat and meat products.(pp. 205-213) London, CAB International.

Kinsella, J.E. (1979). Functional properties of soy proteins. *Journal of American Oil Chemistry Society*,56,242-258.

Mgbabu, C.N. (2011). Determination of Nutritional value of donkey meat sold at NkwoNgbo, Ebonyi State. *Continental Journal of Food Science and Technology,* 5,1-5.

Muir, D.D., Tamine, AV., Khasheli, V. (2000). Effect of processing conditions and raw materials on the properties of Khisk. *Lebensmittel-Wissenschaft und Technologie,* 33, 452-461.

Papanikolaou, G., Pantopoulos, K. (2005). Iron metabolisme and toxicity. *Toxicology and Applied Pharmacology,* 202, 199– 211.

Rawdah, T.N, El-Faer, M.Z., Koreish, S.A. (1994). Fatty acid composition of the meat and fat of the one-humped camel (*Camelus dromedarius*). *Meat Science,* 37, 149–155.

Šarolić, M., Gugić, M., Marijanović,Z., Šuste,M. (2014). Virgin olive oil and nutrition. Food in health and disease. *Sci-Profess Journal of Nutrition and Dietetics* ,3 (1), 38-43.

Schmid, A. (2011). The role of meat fat in the human diet. *Critical Review in Food Science and Nutrition,* 51,50–66.

Suliman, A.M.E., Fadlalmola, S.A., Babiker, A.S.A., Yousif, H.S., Ibrahim, S.M., Abdelrahim, Y.M., Arabi, O.A. (2016). Influence of season and storage period of camel meat on the quality characteristics of burger. *Journal of Food and Nutritionals Disorders*, 5, 1-6.

Tao, L. (2015). Oxidation of poly unsaturated fatty acids and its impact on foodquality and human health. *Advance of Food Technology Nutrition Science* ,1(6), 135-142.

Yasamatsu, K., Sawada, K., Moritaka, S., Misaki, M., Toda, J., Wada, T. (1972). Whipping and emulsifying properties of the soy products. *Agricultural and Biological Chemistry*, 36, 719-728.

Warriss, P.D (2000). An introductory text. *Meat Science*, 6,113-155.

Aknowledgment

This work was supported by a grant of the "Ministère de l'Enseignement Supérieur et de la Recherche Scientifique" of Algeria (ProjectCNEPRU:D01N01UN180120150001)