STUDY THE EFFECT OF SUN AND MICROWAVE DRYING ON QUALITY OF CAMEL MEAT (*Camelus dromedarius*) SLICES

RAHMANI Youcef[1,2,3] and KHAMA Réda[2,4]
[(1)]*Department of Process Engineering, University of Ouargla, 30000 Ouargla, Algeria*
[(2)]*Fac. Applied Sciences, Lab. Process Engineering, University of Ouargla, 30000 Ouargla, Algeria*
[(3)]*Scientific and Technical Research Centre in Physico-Chemical Analysis, 42004 Bousmail, Algeria*
[(4)]*Department of Sciences and Technology, University of Batna 2, 05000 Batna, Algeria*
E-mail: rahmani.youcef@univ-ouargla.dz

(Received 04 November 2021- Accepted 22 June 2022)

Abstract.- *Drying is still considered to be an efficient and important process used for food preservation. Several drying methods are commonly used, so it would be interesting to compare them. The comparison could focus on the quality of the dried products, which is mainly dependent on changes occurring during processing. In the current contribution, an experimental study of drying camel meat (*Camelus dromedarius*) by two methods, namely direct sun drying and microwave drying, is performed. The investigation is carried out to determine the adequate better drying technique for camel meat from the region of Ouargla, southeast Algeria. Under pre-treatment in a saline solution during 30 minutes of soaking, the samples used are slices 8 mm thick, 100 mm long and 20 mm wide. They are characterized by the initial water content of 73.38 ± 0.13%, the protein content of 19.77 ± 0.05%, an ash content of 1.123 ± 0.009 and a lipid content of 3.72 ± 0.05%. The sun drying experiments are carried out at an average temperature of 21.55°C and average relative humidity of 28.57%. The microwave drying is carried out at a power of 180 and 270 W. At the end of drying, kinetics, rate drying, duration drying, organoleptic properties (color and size) and nutritional values (protein and lipid) are determined in each case. Although drying in the microwave is faster and shorter, the results show that the samples sun dried are better. Indeed, sun drying shows a shrinkage rate of 43.63 ± 0.37% against 56.75 ± 0.36% at 180 W and 57.65 ± 0.32% at 270 W for microwave drying, with total color differences of 20.59 ± 0.48 against 24.63 ± 0.73 at 180 W and 23.10 ± 0.70 at 270 W for microwave drying. Protein content increases significantly after sun drying (49.44 ± 0.21) and microwave drying (45.30 ± 0.02% at 180 W and 40.64 ± 0.01 at 270 W). The results also show lipid preservation of 84.13% during sun drying and an increase in ash content in both drying processes from 1.123 ± 0.009 to: (i) 4.235 ± 0.015 at 180 W and 4.266 ± 0.037 at 280 W, in microwave drying; (ii) 3.903 ± 0.07 during sun drying.*

Key words: *Cameline meat, quality, sun drying, microwave drying, experimentation.*

ÉTUDE DE L'EFFET DU SÉCHAGE AU SOLEIL ET PAR MICRO-ONDES SUR LA QUALITÉ DES TRANCHES DE VIANDE CAMELINE (*Camelus dromedarius*)

Résumé.- *Le séchage est toujours considéré comme un processus efficace et important utilisé pour la conservation des aliments. Plusieurs méthodes de séchage sont couramment utilisées, il serait donc intéressant de les comparer. La comparaison pourrait porter sur la qualité des produits séchés, qui dépend principalement des changements qui se produisent pendant le traitement. Dans la contribution actuelle, une étude expérimentale du séchage de la viande cameline (*Camelus dromedarius*) par deux méthodes, à savoir le séchage direct au soleil et le séchage par micro-ondes, est effectuée. L'enquête vise à déterminer la meilleure technique de séchage de la viande cameline de la région de Ouargla, au sud-est de l'Algérie. En prétraitement dans une solution saline pendant 30 minutes de trempage, les échantillons utilisés sont des tranches de 8 mm d'épaisseur, 100 mm de long et 20 mm de large. Ils se caractérisent par une teneur initiale en eau de 73.38 ± 0.13%, une teneur en protéines de 19.77 ± 0.05%, une teneur en cendres de 1.123 ± 0.009 et une teneur en lipides de 3.72 ± 0.05%. Les essais de séchage au soleil sont effectués à une température moyenne de 21.55°C et à une humidité relative moyenne de 28.57%. Le séchage par micro-ondes est effectué à une puissance de 180 et 270 W. A la fin du séchage, la cinétique, le taux de*

séchage, la durée de séchage, les propriétés organoleptiques (couleur et taille) et les valeurs nutritionnelles (protéines et lipides) sont déterminées dans chaque cas. Bien que le séchage au micro-ondes soit plus rapide et plus court, les résultats montrent que les échantillons séchés au soleil sont meilleurs. En effet, le séchage au soleil montre un taux de retrait de 43.63 ± 0.37% contre 56.75 ± 0.36% à 180 W et 57.65 ± 0.32% à 270 W pour le séchage par micro-ondes, avec des différences de couleur totales de 20.59 ± 0.48 contre 24.63 ± 0.73 à 180 W et 23.10 ± 0.70 à 270 W pour le séchage par micro-ondes. La teneur en protéines augmente considérablement après le séchage au soleil (49.44 ± 0.21) et le séchage par micro-ondes (45.30 ± 0.02% à 180 W et 40.64 ± 0.01 à 270 W). Les résultats montrent également une conservation des lipides de 84.13% pendant le séchage au soleil et une augmentation de la teneur en cendres dans les deux processus de séchage de 1.123 ± 0.009 à : (i) 4.235 ± 0.015 à 180 W et 4.266 ± 0.037 à 280 W, pendant le séchage par micro-ondes ; (ii) 3.903 ± 0.07 pendant le séchage au soleil.

Mots clés: *Viande cameline, qualité, séchage au soleil, séchage par micro-ondes, expérimentation.*

Introduction

Camel meat is an essential source of food in arid countries [1,2], and since its moisture content is high, meat is classified as a highly perishable food with a limited shelf life. For the extension of its shelf life, there are several methods available [3,4]; drying is the oldest food conservation process [5]. However, traditional processes take time and can affect end product quality [6]. Variations in drying conditions and the pre-treatment of samples have an important role and they directly influence the physicochemical and microbiological quality of dried meat [7].

Given the economic potential of this meat in the market, with increasing production of camel meat from 2016 to 2019 (5886 tons to 6514 tons respectively according to the statistics of the Food and Agriculture Organization (FAO) [8] and the increasing consumption of camel meat by the people. Several types of researches have been carried out mainly on the composition of this meat, which is close to beef meat except for the low cholesterol content. Studies show the richness of this meat in macro and micronutrients, with a water content near 78 %, total fat of 3 % and an ash content of 1.2%. Also, the cholesterol content tests carried out by studies on this meat is approximately 575.6 mg/kg, which shows this content lower than that of beef (745 mg/kg) [9], camel meat is also a source of vitamins and minerals, and compared to beef, mutton, and chicken, their content is high [10]. The processing of this meat is more often by the traditional drying technic, can study carried out on the processing of camel meat, especially by the drying technique.

In this study, the effect of two methods (sun and microwave drying) on the physicochemical quality of camel meat slices (*Camelus dromedarius*) having undergone cold salting pre-treatment is investigated experimentally. A rigorous comparison then is elaborated.

1.- Material and methods

1.1.- Samples preparation

Fresh meat of young dromedary (*Camelus dromedarius*) was brought from the local slaughterhouse in Ouargla, Algeria, and transported in a cooler to the laboratory. Samples of the

camelina meat were cut into slices 10 ± 0.1 cm long, 2 ± 0.1 cm wide and 0.8 ± 0.1 cm thick, with average initial mass of the slices equal to 13.51 ± 0.20 g. The slices were then salted and dried using different methods.

1.2.- Samples pre-treatment

The pre-treatment of camelina meat slices is carried out by soaking in a new composition of a saline solution prepared at the laboratory level under the condition of a temperature of 4 degrees Celsius and the concentration of the brine was 19 % of sodium chloride. Camelina slices salted in brine were removed from the brine after 30 minutes of residence time.

1.3.- Drying procedures

1.3.1.- Sun drying

Drying has taken place on racks exposed to direct sunlight at a 30° angle and facing south. The samples were dried in January when the temperature was between 17°C and 25°C during the day and the relative humidity of the air varied from 22% to 37%. The rate of moisture loss was measured periodically on the Ohaus adventurer digital balance with an accuracy of 0.0001 g. Data are the average of the results of three tests carried out simultaneously.

1.3.2.- Microwave drying

The samples of camel meat (*Camelus dromedarius*) were dried in a microwave oven IRIS brand (IR-MO30EL) with internal cavity dimensions of 240 mm (height), 354 mm (width), and 358 mm (length), which is characterized by a nominal voltage of 230 V to 240 V, a frequency of 50 Hz and an input power of 1400 W and 900 W output power, with a microwave frequency of 2450 MHz. The microwave oven was the standard oven that can operate at ten different power levels, namely 180, and 270 W. With a 310 mm diameter glass plate rotating at the base of the oven. The adjustment of the processing time and the working power (180 W and 270 W) is carried out using automatic control. During the drying experiments, each sample was placed on a watch glass. The rate of moisture loss was measured periodically by removing the watch glass and quickly weighing on the Ohaus adventurer digital balance with an accuracy of 0.0001 g. Three tests were performed for each selected power and the provided data is an average of these results.

1.4.- Physicochemical analysis

1.4.1.- Moisture content

The Moisture content (MR) represents the amount of moisture remaining in the slices of camelina meat that is relative to the initial water content of fresh meat [4], calculated using Eq.1 [11,12]:

$$MR = \frac{(M-Me)}{M0-Me} \quad (1)$$

Where:
M: is the moisture content of meat slices, in kg water/kg dry matter.
Me: is the equilibrium moisture content of meat slices, in kg water/kg dry matter.
M_0: is the initial moisture content of meat slices, in kg water/kg dry matter.

1.4.2.- Shrinkage measurement

The loss of moisture from camelina meat samples causes a change in the surface of the slices and even collapsing pore structures, in meat, shrinkage is anisotropic [13], shrinkage of slices of camelina meat is determined by a direct method by measuring the dimensions of the samples with the help of a power fix digital package foot before and after each drying method, and the final rate of shrinkage calculated according to the mathematical equation [4]:

$$\text{Shrinkage } (\%) = \frac{(\text{final surface})}{(\text{initial surface})} \text{x } 100 \quad (2)$$

1.4.3.- Protein content

The protein content of fresh and dried slices of camelina meat was calculated by determining the amount of total nitrogen in the samples using the Kjeldahl method and using a common conversion factor of 6.25 as suggested in the literature [14], three measurement tests were carried out for each sample, then the percentage of protein is calculated according to the following equation [14,11].

$$\text{Protein } (\%) = \frac{(V1-V2) \text{ x N x } 0.014}{w} \text{ x } 100 \quad x\, f \quad (3)$$

Where:
V_1: is the volume of 0.1 N hydrochloric acid solution used for the determination, in ml.
V_2: is the volume of 0.1 N hydrochloric acid solution used for the blank test, in ml.
N: is the normality of hydrochloric acid.
f: is the conversion factor.
w: is the mass of the test sample, in grams.

1.4.4.- Total basic volatile nitrogen (TBV-N) content

Nitrogen content of camelina meat is the quantity of nitrogen corresponding to the ammonia produced and determined under the specified conditions described in standard ISO 0937.

The nitrogen content, expressed as a percentage by mass, shall be equal to Eq.4 [16]:

$$\text{N } (\%) = \frac{(V1-V0)}{w} \text{ x } 0.14 \quad (4)$$

Where:
V_0: is the volume of 0.1 N hydrochloric acid solution used for the blank test, in ml .
$V_{1:}$ is the volume of 0.1 N hydrochloric acid solution used for the determination, in ml .
w: is the mass of the test sample, in grams.

1.4.5.- Total fat content

The lipid content was determined by the Soxhlet extraction method with the solvent n-hexane after hydrolysis in hydrochloric acid in three tests for each sample, (R 256 S Buhr Extractor, Germany).

1.4.6.- Determination of pH

The pH of camelina meat was measured before and after drying according to ISO method second edition reference number 2917, using ohaus equipment, pH-metro ST3100 [17].

1.4.7.- Color measurement

The color of the camelina meat slices was determined before and after drying on the surface of the samples using a chromameter (CR-13, KONICA MINOLTA, Tokyo, Japan) at three different locations and The color evaluation was based on the determination of Hunter values L* (white/dark), a* (red/green) and b* (yellow/blue), the total value of the color difference (ΔE) of the camelina meat slices was calculated according to the following equation [3,14]:

$$\Delta E = \sqrt{(\Delta l)^2 + (\Delta a)^2 + (\Delta b)^2} \quad (5)$$

1.4.8.- Ash content

The ash content of the camelina meat was calculated after calcination in a muffle furnace set at 550°C for 3 hours, and the rate was expressed according to equation 6 [11,15] :

$$\text{Ash } (\%) = \frac{(\text{weight of sample after calcination})}{(\text{Weight of dried simple})} \text{x}100 \quad (6)$$

1.5.- Statistical analysis

Experimental data are expressed in mean ± standard deviations. All determinations are made in three copies. A statistical analysis of the results is carried out using the XLS tat 2014 software. An equal mean hypothesis is tested by variance analysis (ANOVA). The means are significantly different from the Newman-Keuls method ($p \leq 0.05$).

2.- Results and discussion

3.1.- Drying kinetics

The drying curve for slices of Camel meat having a pre-treatment in a microwave-dried saline solution (MWD) is shown in figure 1, and the drying curves for sun-dried (SD) (fig. 2.) in order to facilitate the comparison between them. For the microwave, drying curves represents a dissimilar behaviour between the two different powers (170 and 270 W) with a constant drying rate followed by a decreasing rate for the 170 W power and a remark of two different drying rates for the 270 W power, and for the drying curves for the two powers, with two different drying periods. For the solar drying methods, the drying behaviour is similar to a constant drying rate followed by a period of decreasing drying rate.

Figure 1 shows the evaluation of the moisture ration according to the drying time (minute) of the camel meat slices in a microwave at two different powers 270 W and 180 W, the

moisture ration decreases faster in the drying at 270 W in the vicinity of 1080 minutes, and at 180 W the drying time reaches 2000 minutes.

Figure 2 shows the variation of climatic conditions during the sun drying of camel meat, the humidity of the area which is in the vicinity of 20.80% in the morning at the beginning of drying and gradually decreases and arrives at 14.90% at about 13 o'clock, then the increase will begin to reach the 25.3% at 18 o'clock, and the solar radiation (W/m^2) which is 500 (W/m^2) at the beginning of the day and the maximum of 600 (w/m^2) at noon, and the decrease of solar radiation until 17:30, as well as the temperature of the drying area which also has two phases, the first increase from the beginning of the day (20°C) until noon (24.7°C) and decreases at the end of the day, reaches 17 degrees.

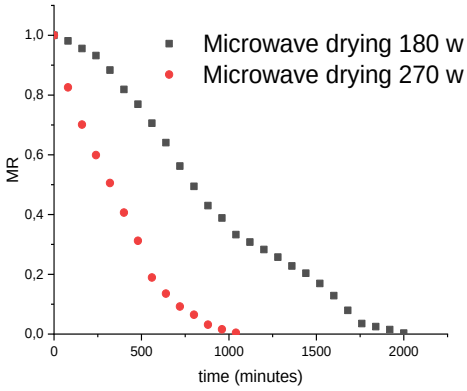

Figure 1.- Evaluation of moisture ration of meat camelina in microwave drying.

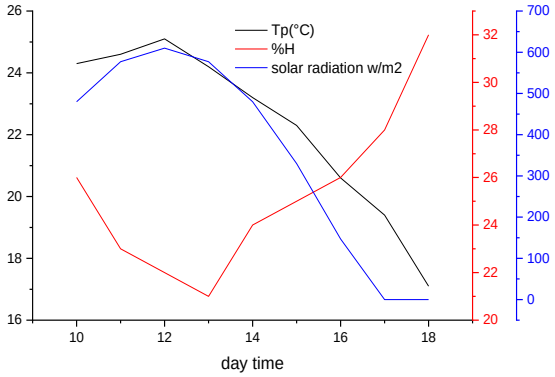

Figure 2.- Representative climatic conditions during sun drying.

Figure 3 represents the kinetics of sun drying of camelina meat slices which tends to be slower than the microwave drying method, the water content of the slices in the initial state before drying will start from 74% and takes a slight decrease during this period of conditioning in the first two hours, a severe decrease in four hours and an increase in drying speed due to the climatic condition followed by a partial spread at the end of the drying.

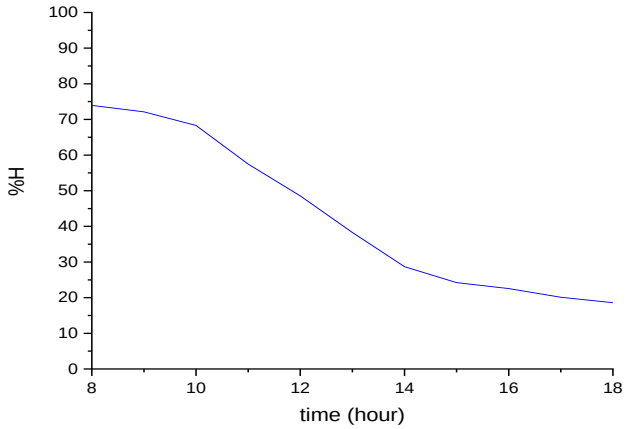

Figure 3.- Evaluation of moisture content of slices camelina meat.

2.2.- Color and protein contents

The color degradation of camelina meat increases slightly with increasing temperatures and drying power as well as the crude protein content of camelina meat slices which are close to previous studies on fresh meat [20] and the values included in the table (tab. I) but not significant ($p < 0.05$) different. in the study done by KISEMBE *et al.* (2017) [21], the protein content was close to 49.68 ± 1.9%, a value close to that found in the present study (49.44 ± 0.21%) in sun-dried meat.

2.3.- Total basic volatile nitrogen

The total volatile basic nitrogen dosage is intended to determine the degree of alteration of the slices of camelina meat [22]; it is inversely proportional to the level of protection of protein, samples of fresh camelina meat slices, with an initial TVBN of 13.62 ± 0.03 increased during drying time by the different methods used [23], and it is noted that the method with a lower content is microwave drying at the power of 180 W (25.42 ± 0.30).

3.4.- Moisture content and shrinkage

The final moisture content of the slices of camelina meat dried by different methods is different from one method to another and the lowest moisture content corresponds to the drying by microwave method (MD) at 270 W which has lowered the drying rate by 86.06%, and a proportional relationship with the rate of shrinkage for the slices dried with different methods [17].

Table I.- Characteristics of the fresh and dried camelina meat slices

Parameters (%)		Fresh camelina meat	Microwave drying		Sun drying
			180 Watt	270 Watt	
H (%)		73.38 ± 0.13[a]	11.42 ± 0.05[a]	10.31 ± 0.08[a]	18.44 ± 0.06[a]
Dry matter		88.58 ± 0.13[a]	89.69 ± 0.05[a]	86.21 ± 0.08[a]	88.58 ± 0.06[a]
Ash		1.123 ± 0.009[a]	4.235 ± 0.015[a]	4.266 ± 0.037[a]	3.903 ± 0.07[a]
Protein		19.77 ± 0.05[a]	45.30 ± 0.02[a]	40.64 ± 0.01[a]	49.44 ± 0.21[a]
TBNV		13.62 ± 0.03[a]	25.42 ± 0.30[a]	27.33 ± 0.10[a]	28.90 ± 0.02[a]
Lipid		3.72 ± 0.05[a]	1.23 ± 0.02[a]	0.81 ± 0.10[a]	3.13 ± 0.06[a]
Salt		-	3.22 ± 0.07[a]	3.30 ± 0.10[a]	2.90 ± 0.06[a]
Ph		5.96 ± 0.02[a]	6.18 ± 0.02[a]	6.17 ± 0.01[a]	6.13 ± 0.01[a]
Color	l*	37.13 ± 2.11[a]	20.56 ± 16 [a]	24.01 ± 1.58	25.78 ± 0.90
	a*	22.03 ± 2.15[a]	4.15 ± 0.52[a]	3.47 ± 0.40[a]	5.97 ± 1.08[a]
	b*	7.73 ± 0.47[a]	4.41 ± 0.57[a]	3.73 ± 0.10[a]	1.72 ± 0.40[a]
Total color change ΔE		-	24.63 ± 0.73[a]	23.10 ± 0.70[a]	20.59 ± 0.48[a]
Shrinkage		-	56.75 ± 0.36[a]	57.65 ± 0.32[a]	43.63 ± 0.37[a]

3.5.- Salt content and pH measurement

The pH of the slices of dried camelina meat goes from 5.956 ± 0.087 for fresh meat to a lower acidity corresponds to 6.203 ± 0.091 under static drying at a temperature of 65°C. In the

study developed by [24], where the effect of gum Arabic (Acacia Senegal) powder coating level and sun drying period on chemical composition and color of dry camel meat was evaluated, the pH obtained was 5.80. The acidity values decrease with increasing salt content expressed in sodium chloride [25] and the salt content obtained is considered to be low and very close to the salt content of viands already treated by the salting method [26].

Conclusion

The study of the drying of camel meat slices dried in the sun and in the microwave shows the differences between the drying kinetics and the nutritional quality value, the new composition of the saline solution based on sodium chloride used in the pre-treatment is effective and preserves the nutritional quality, especially in the sun drying and in the climatic conditions recorded in Ouargla city (south of Algeria) in a way that assures the preservation of the color, protein and lipid, and less total salinity.

Acknowledgments: The authors thank the managers and engineers of the research centre and of the faculty of applied sciences at University of Ouargla. They thank Dr. El Bouti Khamra, veterinary inspector direction of the agricultural department of Ouargla (DSA), for their support in the realization of this work and the experimental facilities.

References

[1].- Faye B.; Abdelhadi O.; Raiymbek G.; Kadim, I. Hocquette J. F., 2013.- La production de viande de chameau: État des connaissances, situation actuelle et perspectives. Prod. Anim., 26, 289-300.

[2].- Rahmani Y. and Khama R., 2021.- Effect of thickness and pretreatment on the physicochemical quality of sun-dried camelina meat. In Proceedings of the Sixth International Seminar on New and Renewable Energies ; Ghardaia, 62p.

[3].- Vallespir F.; Rodríguez Ó.; Eim V. S.; Rosselló C.; Simal S., 2018.- Freezing pre-treatments on the intensification of the drying process of vegetables with different structures. Journal of Food Enginnering, 239: 83-91.

[4].- Aksoy A.; Karasu S.; Akcicek A.; Kayacan S., 2019.- Effects of different drying methods on drying kinetics, microstructure, color, and the rehydration ratio of minced meat. Foods 8(6), 216.

[5].- Gaukel V., Siebert T. and Erle U., 2017.- Microwave-assisted drying. In The microwave processing of foods, Pp 152-178.

[6].- Bourdoux S., Li D., Rajkovic A., Devlieghere F. and Uyttendaele M. 2016.- Performance of drying technologies to ensure microbial safety of dried fruits and vegetables. Comprehensive Reviews in Food Science and Food Safety, 15(6): 1056-1066.

[7].- Zakaria B. and Abdelhakim S., 2020.- Contribution à l'étude de la consommation de la

viande cameline et mise en evidence d'une typologie des consommateurs dans la region du souf Sahara Septentrional Algerien. Alger. J. Arid Environ., 10, 77- 87.

[8].- Rahmani Y.; Khama R., 2020.- Analyse physico-chimique de la viande cameline séchée au soleil. Natl. Conf. Energy Syst. Environ. Plasma Mater, "ESEPM2020", MESTEL Lab. Univ. Ghardaïa, Alger, 79-80.

[9].- Hamed Hammad Mohammed H.; Jin G.; Ma M.; Khali I.; Shukat R.; Elkhedir A. E.; Zeng Q. Noman A. E., 2020.- Comparative characterization of proximate nutritional compositions, microbial quality and safety of camel meat in relation to mutton, beef, and chicken. Lwt 118, 108714.

[10].- Baba W. N., Rasool N., Selvamuthukumara M., and Maqsood S., 2021.- A review on nutritional composition, health benefits, and technological interventions for improving consumer acceptability of camel meat: an ethnic food of Middle East. Journal of Ethnic Foods, 8(1): 1-13.

[11].- Chaouch W. B.; Khellaf A.; Mediani A.; Slimani M. E. A.; Loumani A.; Hamid A., 2018.- Experimental investigation of an active direct and indirect solar dryer with sensible heat storage for camel meat drying in Saharan environment. Sol. Energy, 174: 328-341.

[12].- Daş M., Alıç E. and Akpinar E. K., 2021.- Numerical and experimental analysis of heat and mass transfer in the drying process of the solar drying system. Engineering Science and Technology, an International Journal, 24(1): 236-246.

[13].- S. Kassama L.; Ngadi M., Shrinkage and 2016.-Density Change of De-Boned Chicken Breast during Deep-Fat Frying. Food Nutr. Sci. 07: 895-905.

[14].- Jain A., Jain R., Jain, S., 2020.- Fat Characterization. In Basic Techniques in Biochemistry, Microbiology and Molecular Biology. Springer Protocols Handbooks, Pp 265-272.

[15].- Hussein H. A., Salman M. N. and Jawad A. M., 2020.- Effect of freezing on chemical composition and nutritional value in meat. Drug Invention Today, 13(2), 329-334.

[16].- Mc Clements D. J., Weiss J., Kinchla A. J., Nolden A. A. and Grossmann L., 2021.- Methods for Testing the Quality Attributes of Plant-Based Foods: Meat-and Processed-Meat Analogs. Foods, 10(2), 260.

[17].- Teixeira, A., Silva, S., Guedes, C., & Rodrigues, S. 2020.- Sheep and Goat Meat Processed Products Quality: A Review. Foods, 9(7), 960.

[18]. - Faustman C. and Suman S. P., 2017.- The eating quality of meat: I—Color. In Lawrie´ s meat science, Pp 329-356.

[19].- Eleonora O, Bahytkul A. M. R., 2017.- Study of morphology, chemical, and amino acid composition of red deer meat. Vet. World, 10(6): 623-629.

[20].- Suliman G. M., Alowaimer A. N., Hussein E. O., Ali H. S., Abdelnour S. A., El-Hack M. E. A. and Swelum A. A., 2019.- Chemical composition and quality characteristics of meat in three one-humped camel (Camelus dromedarius) breeds as affected by muscle type and post-mortem storage period. Animals, 9(10), 834.

[21].- Kisembe S.W, Muliro P.S., Matofari J.W. and B.O. Bebe, 2017**.-** An evaluation of nutritional quality of traditionally processed camel meat (Nyirinyiri): Value chain assessment and recommendations. Int. J. Nutr. Food Sci., 6(4): 172-174.

[22].- Lee H.; Kim M. S.; Lee W. H.; Cho B. K, 2018.- Determination of the total volatile basic nitrogen (TVB-N) content in pork meat using hyperspectral fluorescence imaging. Sensors Actuators, B Chem. 259: 532-539.

[23].- Yang Q.; Sun D. W.; Cheng W., 2017.- Development of simplified models for nondestructive hyperspectral imaging monitoring of TVB-N contents in cured meat during drying process. J. Food Eng., 192: 53-60.

[24].- Ibrahim G.A. and Nour I. A., 2010.- Physical and chemical properties of camel meat burgers. J. Camelid Sci., 3: 39-43.

[25].- Puolanne E.; Peltonen J., 2013.- The effects of high salt and low pH on the water-holding of meat. *Meat Sci. 93:* 167-170.

[26].- Delgado-Pando G.; Fischer E.; Allen P.; Kerry J. P.; O'Sullivan M. G.; Hamill R. M., 2018.- Salt content and minimum acceptable levels in whole-muscle cured meat products. *Meat Sci. 139:* 179-186.