JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2018, *24* (1), 26-33

*Journal of Agroalimentary Processes and Technologies*

# Comparative studies of amino acid, fatty acids and proximal chemical composition content of donkey, dog, camel, beef and goat liver

**Hala Mahmoud Bayomy[1], Mahmoud Abdelgelil Rozan[1] , Uzma Faridi[2]**

[1]*Damanhour University, Egypt*
[2]*University of Tabuk, Saudi Arabia*

***Abstract***

Liver is an excellent source of all the biological molecules like essential, nonessential amino acids and long change omega 6 and omega 3 fatty acids. The objective of present study was to comparison the nutrition value of liver samples donkey, dog, camel, beef and goat by using standard methods. All the samples shown good content of amino acids, fatty acids, total protein content and moisture, also data illustrated that the differences between all samples understudy were significant ($p<0.05$). Glutamic acid is present in liver in the highest amounts (9.16%) of non-essential amino acids, followed by aspartic acid, cysteine was present in the lowest amount in all types of livers. Leucine was present in the highest percent among of essential amino acids followed by lysine. Camel liver have the highest value of myristic acid (3.11%) and palmitic acid (33.29%), beef liver have the highest value of margaric acids (3.26%) and stearic acid (42.93%). ɤ-Linolenic acid was absent only in dog's and donkey's livers. The high level of protein (67.47% dw) and low level of crude fat (6.49% dw) were determined in donkey liver, while the highest level of fat (11.69%) were determined in goat liver ($P < 0.05$). According to the types of liver, protein content differs but not as much as fat content which ranged from 11.69 to 6.49% ($P < 0.05$). The moisture content was almost equal (70-71%) in all kind of liver samples except goat which had 67.70 % moisture.

***Keywords***: Liver; Chemical composition; amino acids; fatty acids

## 1. Introduction

The Liver is considered to be a valuable source of nutrients especially different kinds of fatty acids, amino acids, minerals and vitamins [1] The liver is considered to contain all types of vitamins especially Vitamin A. The liver is a good source of amino acids and fatty acids. Amino acids, the building blocks of protein are very important in almost biological processes. They also affect the function of organs, hormones etc. They are also important for tissue repairing in muscles, skin and bones. Many essential amino acids are also present liver is a good source of amino acids as well especially the essential amino acids. Amino acids are very important for growth [2].

Essential amino Acids are mostly responsible for the amino acid stimulation of muscle protein synthesis [3]. Protein from meat especially liver has almost all the essential and non-essential amino acids [4]. Many polyunsaturated fatty acids (PUFA) are also present in the liver which is good for health as they reduce the cholesterol [5]. Lipid has very important effect on human health, but high consumption may cause high plasma and heart disease [6]. Saturated fatty acids are important source of energy and the unsaturated fatty acids especially, polyunsaturated fatty acids play important role in reducing serum cholesterol concentration, low-density lipoprotein-C, they have some important role in modulation of immune function and inflammatory system [7,8].

Corresponding author: *e-mail:* Hala.biomy@agr.dmu.edu.eg

The present investigation was conducted to compare the percentage of amino acids, fatty acids and proximate chemical composition in the liver of donkey, dog, camel, beef and goat.

## 2. Materials and Methods

***Liver Samples:*** Fresh donkey and dog livers were collected from Alexandria zoo, Alexandria, Egypt. Lamb, Camel and beef livers were obtained from local market. All the samples (mince) were kept frozen (-20 °C) at Kilner jar until analyzed.

***Methods:*** The minced liver samples were analysed for moisture, total protein, saturated and unsaturated fatty acids, essential and non-essential amino acids and ash contents in accordance with standard AOAC methods [9].

***Determination of essential and non-essential amino acids*:** Amino acids were analysed by using AOAC method [9]. The minced liver samples were hydrolysed with 6 N HCl for 24 h and amino acids were quantified using the Beckman Amino Acid Analyser (model 6300; Beckman Coulter Inc., Fullerton, Calif., U.S.A.) employing sodium citrate buffers as step gradients with the cation exchange post-column ninhydrin derivatization method. The data was reported as mg of amino acid per 1 g of sample.

***Determination of saturated and unsaturated fatty acid:***Saturated and unsaturated fatty acids were analysed by method described by *Folch et al. (1959)* [10] and AOAC (1995, method no. 996.06) [9]. 10 gram of sample (each) was taken for fatty acid analysis. Briefly described as 5mL chloroform/methanol (2: 1, v/v) solution was added to each sample and shook thoroughly by vortexing for 3 mins. 1mL of 0.9% NaCl was added to mixture and vortexed again. The chloroform phase containing lipids were collected. Lipid extracts were converted to fatty acid methyl esters as described by *AOAC (1995)* [9]. It was prepared after alkaline hydrolysis following procedures. Briefly, lipid extract was mixed with 0.5N 2mL methanolic NaOH and held at 100°Cfor 10 min. This solution was cooled to room temperature and mixed with 2mL of (14% Borontrifluoride, 86% Methanol). After that, solution was incubated at 100°C for 2 min and cooled dawn to again room temperature. 1mL n-heptane was added to final solution and thoroughly mixed by vortex for 3min and reheated to 100°C for 1min. Final solution was cooled down to room temperature and centrifuged at 300 rpm for 5min. Upper layer (heptane phase) was transferred to glass tube for the GC analysis. The fatty acid analysis was done by gas chromatography (Perkin Elmer Auto system XL) equipped with flame ionization detector a DB5 silica capillary column (60m x 0.32 mm i.d.). the oven temperature was maintained initially at 45 °C and programmed to 60°C. at a rate 1°C/ min, then it programmed from 60°C to 240°C at a rate of 3°C/ min. Helium was used as the carrier gas at flow rate 1ml/min. the injector and detector temperatures were set at 230°C and 250°C, respectively. The final concentration of the fatty acid methyl esters analyses was approximately 7mg/mL in heptane.

***Determination of proximate chemical composition*:** Proximate compositions of the various liver were determined using AOAC methods (1995, method no 934.06). All analysis was done in triplicate. Moisture content was analyzed by the differences in weight before and after drying in oven at 100-105˚C, the ash content was determined by igniting the sample at 550˚C for 5-6 hours until the sample was completely free from carbon particles in a carbolite muffle furnace while the total nitrogen was determined by Kjeldahl method as described by AOAC (1995, method no. 981.10) and a factor of 6.25 was used for converting the total nitrogen to crude protein.

***Statistical Analysis.*** One way analysis of variance (ANOVA) was carried out on the data obtained in other to determine any significant difference in the various types of liver Significance was assumed at ($P < 0.05$).

## 3. Results and Discussions

***Essential and non-essential amino acids (in percentage):*** Liver is a very good source of essential and non-essential amino acids [33]. Liver contains almost all the essential amino acids (lysine, threonine, methionine, phenylalanine, tryptophan, leucine, isoleucine, valine) and has no limiting amino acids [4]. Results in Table (1) showed that the differences in non-essential amino acids contents between all samples were significant ($p<0.005$). Glutamic acid is present in liver in the highest amounts (9.16%), followed by aspartic acid, alanine and valine. Cysteine was present in the lowest amount in all types of livers as shown in figure (1).

As shown in Table (2) and figure (2), Data revealed that the differences in essential amino acids were significant ($p<0.05$) in all types of liver under study. Leucine was present in the highest percent followed by lysine in all the samples.

Amino acids balance the pH of the body, also help in cell repairing and provide energy they repair bones and cells [11-15]. Glutamic acids acts as neurotransmitters and helps in facilitating the communication of the brain and nerve cells. Arginine plays very important role in development of immune system. Cysteine play role in shape maintenance of cells. The presence of amino acids also enables vitamins and minerals to perform all their important functions. Essential amino acids have many other functions. Without these essential amino acids, the human body is unable to function normally and in some extreme cases, cause death [32].

**Saturated and unsaturated fatty acid.** Liver is the good source of both saturated and unsaturated fatty acids [5]. In our studies we found that all five kinds of liver used in study contain saturated and unsaturated fatty acids. In saturated fatty, Data illustrated that the differences between all samples understudy were significant ($p<0.05$) as shown in Table (3). Camel liver have the highest value of myristic acid (3.11%) and palmitic acid (33.29%), whereas the lowest value for these acids found in donkey (0.40%) and beef (15.02%), respectively. Beef liver have the highest value of margaric acids (3.26%) and stearic acid (42.93%), the lowest value of margaric acid (0.38%) and stearic acid (42.93%) found in dog liver and camel liver, respectively. Saturated fatty acids play important role in different biological functions like source of metabolic energy and in cell membrane structure formation [6].

***Table 1.*** Non-essential amino acids (in percentage)

| Non-essential Amino acid | Donkey | Dog | Camel | Beef | Goat |
|---|---|---|---|---|---|
| Aspartic acid | $6.54\pm0.08^{ab}$ | $6.84\pm0.16^{a}$ | $6.30\pm0.05^{b}$ | $5.89\pm0.31^{c}$ | $3.26\pm0.04^{d}$ |
| Serine | $3.26\pm0.17^{b}$ | $3.55\pm0.07^{a}$ | $2.84\pm0.07^{c}$ | $2.47\pm0.03^{d}$ | $1.52\pm0.02^{e}$ |
| Glutamic acid | $8.70\pm0.06^{b}$ | $9.16\pm0.11^{a}$ | $7.87\pm0.06^{c}$ | $7.67\pm0.08^{d}$ | $4.51\pm0.03^{e}$ |
| Proline | $3.76\pm0.03^{a}$ | $3.45\pm0.02^{b}$ | $3.12\pm0.03^{c}$ | $3.02\pm0.04^{c}$ | $1.58\pm0.04^{d}$ |
| Glycine | $4.27\pm0.21^{a}$ | $4.00\pm0.05^{b}$ | $3.40\pm0.03^{d}$ | $3.67\pm0.06^{c}$ | $1.99\pm0.07^{e}$ |
| Alanine | $5.01\pm0.06^{a}$ | $5.21\pm0.04^{a}$ | $3.98\pm0.07^{b}$ | $3.70\pm0.04^{c}$ | $2.01\pm0.06^{d}$ |
| Valine | $4.74\pm0.14^{a}$ | $4.83\pm0.05^{a}$ | $3.98\pm0.08^{b}$ | $3.62\pm0.06^{c}$ | $2.05\pm0.05^{d}$ |
| Tyrosine | $2.42\pm0.06^{b}$ | $2.42\pm0.02^{b}$ | $2.65\pm0.02^{a}$ | $2.55\pm0.11^{a}$ | $1.40\pm0.03^{c}$ |
| Arginine | $3.82\pm0.04^{b}$ | $4.03\pm0.06^{a}$ | $3.73\pm0.04^{c}$ | $3.49\pm0.01^{d}$ | $2.00\pm0.02^{e}$ |
| Cysteine | $1.21\pm0.05^{ab}$ | $1.10\pm0.05^{b}$ | $1.07\pm0.06^{b}$ | $1.37\pm0.02^{a}$ | $0.55\pm0.07^{c}$ |

*Means ± SD in a row not sharing the superscript are significantly different at $p<0.05$.

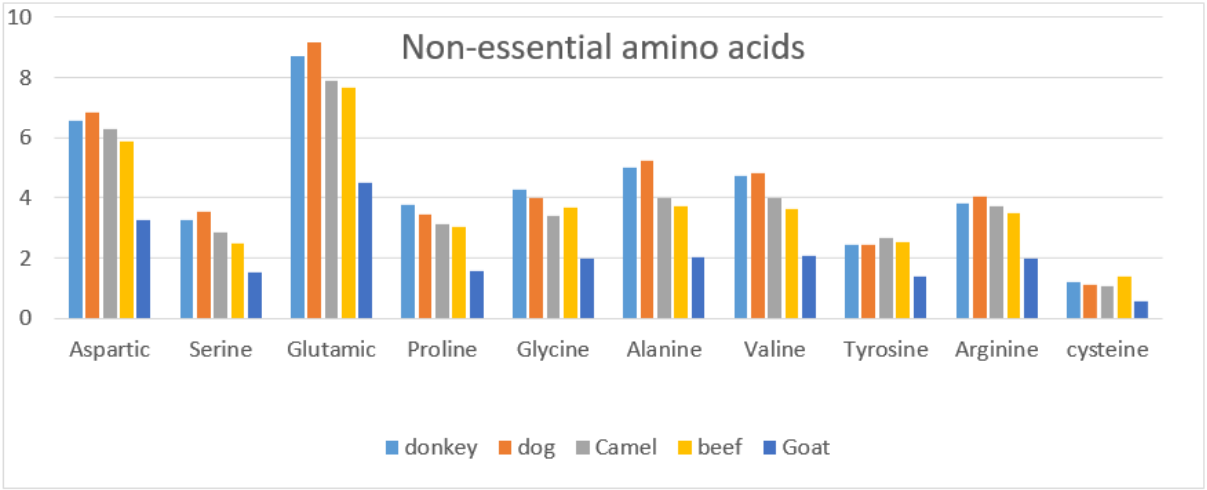


***Figure 1.*** Non-essential amino acids (in percentage).

***Table 2.*** Essential amino acids (in percentage).

| Essential Amino acid | Donkey | Dog | Camel | Beef | Goat |
|---|---|---|---|---|---|
| Methionine | 1.87±0.05$^{a}$ | 1.92±0.04$^{a}$ | 1.5±0.04$^{b}$ | 1.32±0.03$^{b}$ | 0.68±0.03$^{c}$ |
| Isoleucine | 3.48±0.17$^{a}$ | 3.66±0.06$^{a}$ | 3.03±0.05$^{b}$ | 2.79±0.05$^{c}$ | 1.58±0.02$^{d}$ |
| Leucine | 6.76±0.21$^{b}$ | 6.99±0.17$^{a}$ | 6.04±0.10$^{c}$ | 5.46±0.06$^{d}$ | 3.12±0.05$^{e}$ |
| Phenylalanine | 3.23±0.08$^{b}$ | 3.23±0.20$^{b}$ | 3.69±0.07$^{a}$ | 3.33±0.02$^{b}$ | 1.95±0.01$^{c}$ |
| Histidine | 1.89±0.03$^{b}$ | 1.94±0.02$^{b}$ | 2.23±0.02$^{a}$ | 1.85±0.03$^{b}$ | 1.18±0.02$^{c}$ |
| Lysine | 5.7±0.05$^{b}$ | 6.01±0.13$^{a}$ | 4.2±0.02$^{c}$ | 3.45±0.05$^{d}$ | 1.87±0.07$^{e}$ |
| Tryptophan | 0.34±0.03$^{a}$ | 0.27±0.04$^{ab}$ | 0.21±0.01$^{b}$ | 0.26±0.02$^{ab}$ | 0.22±0.04$^{b}$ |
| Threonine | 3.38±0.12$^{a}$ | 3.56±0.13$^{a}$ | 2.94±0.03$^{b}$ | 2.53±0.06$^{c}$ | 1.53±0.06$^{d}$ |

*Means ± SD in a row not sharing the superscript are significantly different at p<0.05

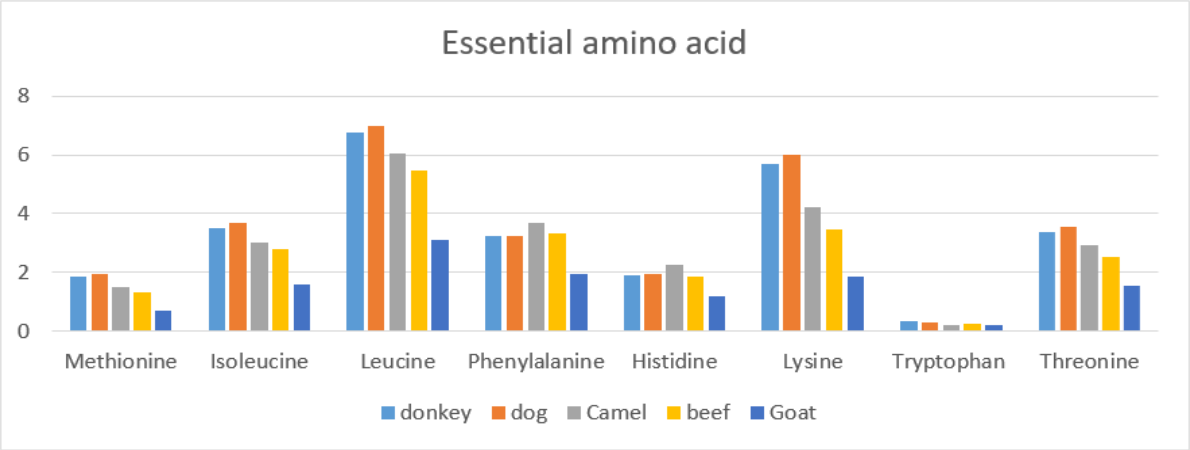


***Figure 2.*** Essential amino acids (in percentage).

***Table 3.*** Saturated Fatty acid (in %)

| Fatty acid | donkey | dog | Camel | Beef | Goat |
|---|---|---|---|---|---|
| C14:0 Myristic acid | 0.40±0.02$^{b}$ | 0.57±0.02$^{b}$ | 3.11±0.03$^{a}$ | 0.49±0.02$^{b}$ | 2.96±0.05$^{a}$ |
| C16:0 Palmitic acid | 16.18±0.36$^{d}$ | 27.39±0.32$^{b}$ | 33.29±0.27$^{a}$ | 15.02±0.21$^{d}$ | 22.48±0.26$^{c}$ |
| C17:0 Margaric acid | 0.57±0.04$^{d}$ | 0.38±0.09$^{d}$ | 2.12±0.04$^{b}$ | 3.26±0.06$^{a}$ | 1.36±0.04$^{c}$ |
| C18:0 Stearic acid | 16.28±0.09$^{b}$ | 11.33±0.05$^{d}$ | 7.80±0.16$^{e}$ | 42.93±0.37$^{a}$ | 12.87±0.09$^{c}$ |

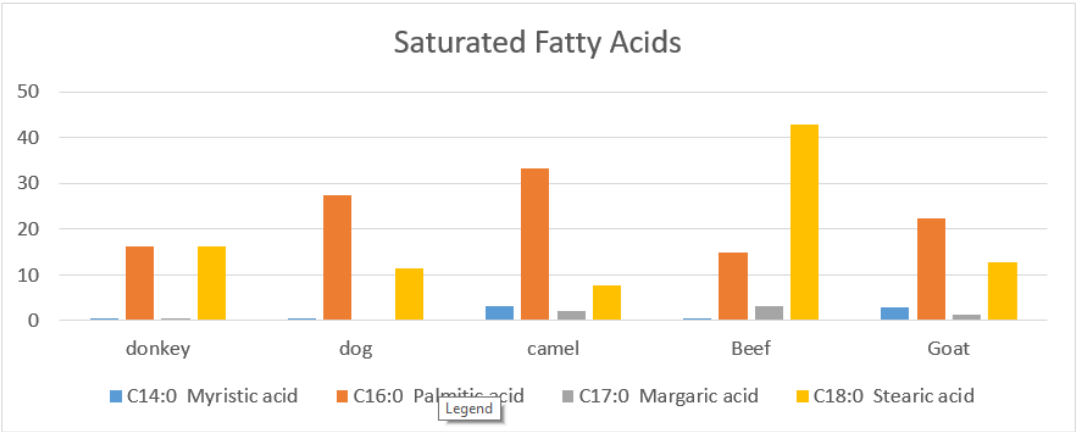


***Figure 3.*** Saturated fatty acids (in percentage).

***Table 4.*** Unsaturated Fatty acids (in %)

| Fatty acid | Donkey | Dog | Camel | Beef | Goat |
|---|---|---|---|---|---|
| Oleic acid | 17.72±0.19$^{c}$ | 14.60±0.14$^{d}$ | 25.33±0.29$^{b}$ | 17.90±0.25$^{c}$ | 48.12±0.19$^{a}$ |
| Linoleic acid | 48.59±0.31$^{a}$ | 22.40±0.31$^{b}$ | _ | 10.16±0.07$^{d}$ | _ |
| ɤ-Linolenic acid | _ | _ | 25.94±0.63$^{a}$ | 4.68±0.19$^{b}$ | 10.76±0.11$^{a}$ |
| Eicosapentaenoic acid | 0.26±0.04$^{d}$ | 19.26±0.15$^{a}$ | 2.41±0.06$^{c}$ | 5.56±0.03$^{b}$ | 0.74±0.02$^{d}$ |
| Docosapentaenoic acid | _ | 4.08±0.07$^{a}$ | _ | _ | 0.73±0.01$^{d}$ |

*Means ± SD in a row not sharing the superscript are significantly different at p<0.05.

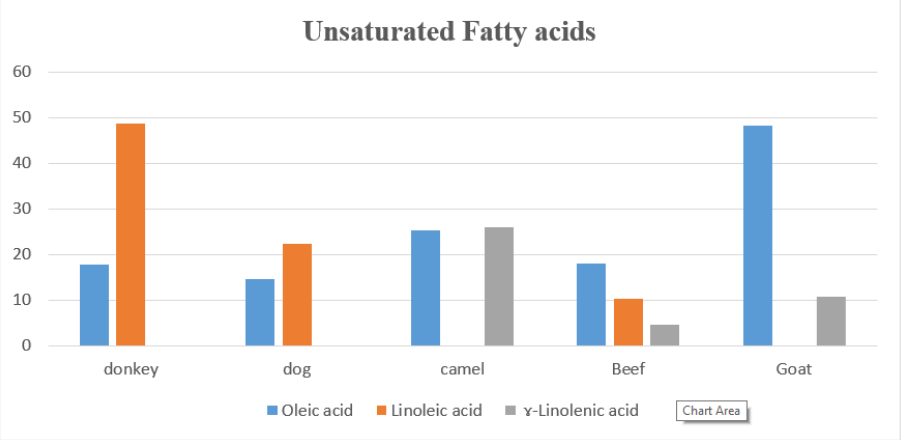


***Figure 4.*** Unsaturated fatty acids (in percentage).

Although fatty acids have an important impact on human health, but the high consumption of saturated fatty acids is associated with CVDs, and obesity. [27]. Our studies indicating the liver is a good source of unsaturated fatty acids as well. Oleic acid was present in all the livers we studied and was in highest percent (48.12%) in goat liver, while the lowest percent (14.60%) in dog liver. Linoleic acid was absent in camel and goat as shown in figure (4). Interestingly ɤ-Linolenic acid was present only in camel, beef and goat liver which are commonly consumed as food source.

Oleic acid, has effect on cancer and inflammatory diseases it also helps in wound healing [16]. Linoleic acid can be converted into omega-6 fatty acid like ɤ-linolenic acid (GLA) which is an omega-6 fatty acid and is considered to be an essential fatty acid and plays a crucial role in brain function, and normal growth and development [16-25].

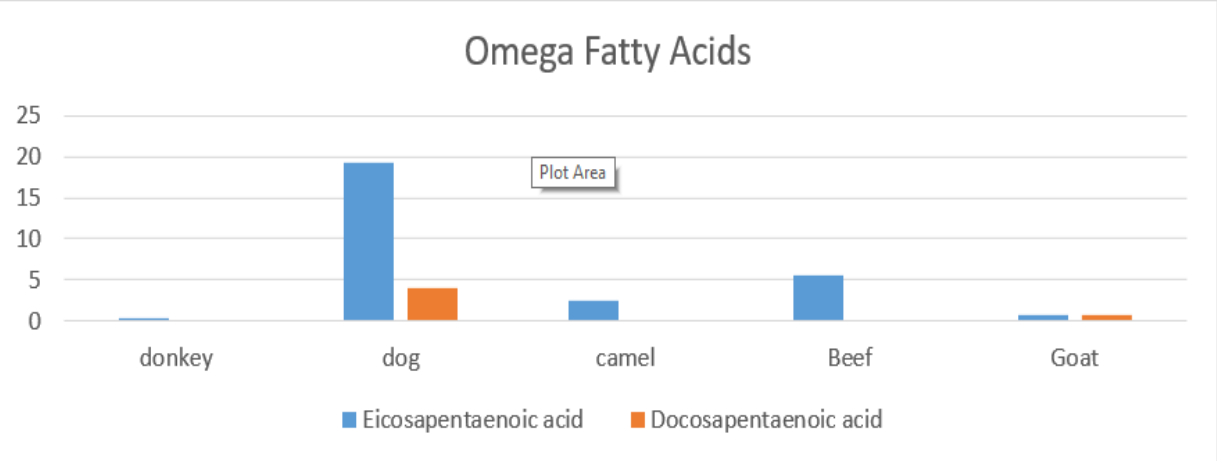


***Figure 5.*** Omega fatty acids (in percentage).

***Table 5.*** Proximate chemical composition

| Sample | % Moisture | Dry matter | Organic matter | Ash | % in dry matter | |
|---|---|---|---|---|---|---|
| | | | | | Ether Extract | Total protein |
| Donkey | 70.12±0.44$^{b}$ | 29.88±0.21$^{b}$ | 95.67±0.63$^{b}$ | 4.33±0.07$^{a}$ | 6.49±0.16$^{d}$ | 67.47±1.86$^{a}$ |
| Dog | 71.97±0.42$^{a}$ | 28.03±0.18$^{c}$ | 95.16±0.48$^{b}$ | 4.84±0.04$^{a}$ | 10.12±0.32$^{c}$ | 65.67±0.46$^{b}$ |
| Camel | 70.69±0.51$^{b}$ | 29.31±0.13$^{b}$ | 95.46±0.30$^{b}$ | 4.54±0.13$^{a}$ | 11.42±0.27$^{a}$ | 63.99±1.29$^{c}$ |
| Beef | 70.68±0.38$^{b}$ | 29.32±0.23$^{b}$ | 95.78±0.27$^{ab}$ | 4.22±0.08$^{a}$ | 10.89±0.19$^{b}$ | 61.04±0.49$^{d}$ |
| Goat | 67.70±0.47$^{c}$ | 32.30±0.20$^{a}$ | 96.77±0.41$^{a}$ | 3.23±0.08$^{b}$ | 11.69±0.06$^{a}$ | 40.95±0.37$^{e}$ |

*Means ± SD in a column not sharing the superscript are significantly different at p<0.05.

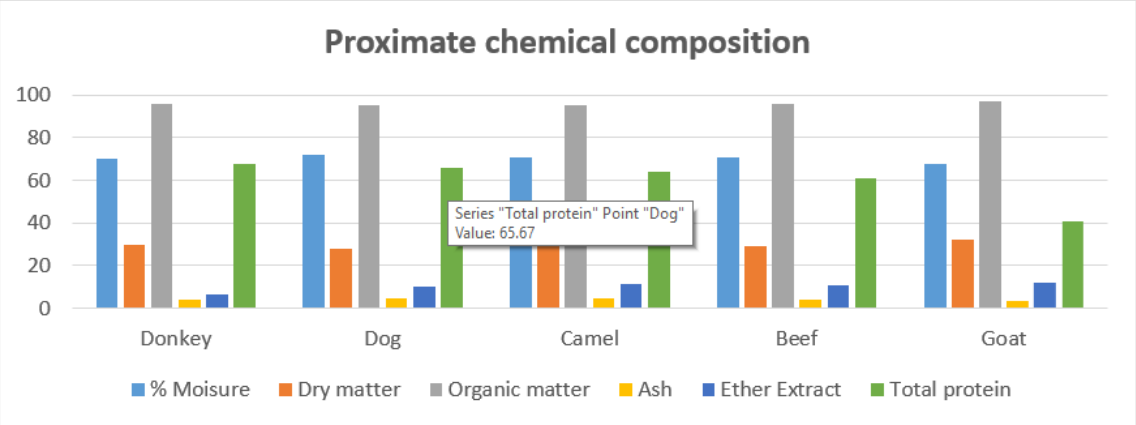


***Figure 6***. Proximate chemical composition.

Eicosapentaenoic acid (EPA) and Docosapentaenoic acid (DHA) are example of omega-3 fatty acids. Dog liver have the highest value of Eicosapentaenoic (19.26%) and Docosapentaenoic acid (4.08%) they play very important role in foetal development and healthy aging [26, 30, 31] and beneficial in prevention and treatment of several diseases [29].

***Proximate Chemical Composition:*** The liver consumption can play important role in human nutrition because of their nutritive value. The value of nutrition is measured in terms of the major chemical components such as proteins, fats, carbohydrates, minerals and fatty acids contents [28].

The proximate compositions of livers expressed as dry weight basis are presented in Table 5. The high level of protein (67.47%) and low level of crude fat (6.49%) were determined in donkey liver, while the low level of protein (40.95%) and high level of fat (11.69%) were determined in goat liver ($P < 0.05$). According to the types of liver, protein content differs but not as much as fat content which ranged from 11.69 to 6.49% ($P < 0.05$).

The moisture content was almost equal (70-71%) in all kind of liver samples except goat which had 67.70 % moisture.

## Conclusion

In this study we have realized that donkey, dog, camel, beef and goat liver presents important source in terms of essential and nonessential amino acids, long chain omega 6 and omega 3 fatty acids. Donkey liver has high protein and low fat than other samples. The present study is indicting the liver can be a good source of macromolecules.

**Acknowledgements:** Disclosure statement: The authors declare that there is no conflict of interest

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

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