COMPARATIVE EVALUATION OF AMINO ACID PROFILE OF CAMEL RED OFFAL (HEART, LIVER AND KIDNEY)

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ABSTRACT
This study evaluates the amino acid profiles of camel red offal (liver, heart, and kidney) to highlight their nutritional significance. The concentrations of essential and non-essential amino acids were analysed, revealing significant differences among the organs (P<0.05). The liver exhibited the highest levels of leucine (6.29 g/100g), lysine (4.73 g/100g), methionine (2.29 g/100g), glutamic acid (10.35 g/100g) and aspartic acid (9.36 g/100g), establishing it as the most nutrient-dense organ. The heart was notable for its proline (3.03 g/100g) and cystine (1.09 g/100g) content, which are essentials for collagen synthesis and antioxidant defense. The kidney demonstrated moderate amino acid levels, with notable contributions in tyrosine (3.11 g/100g) and serine (3.25 g/100g). These findings underscore the potential of camel red offal as valuable dietary sources of high-quality protein and essential nutrients, particularly in arid regions where camel meat is a staple. The study provides a basis for promoting the utilization of camel offal in food formulations to enhance nutritional outcomes.
Keywords:[U2] Camel, Red offal, Liver, Protein sources, Amino acid profile, Nutritional evaluation**.**

INTRODUCTION
Camelids, particularly the dromedary camel (*Camelus dromedarius*), are essential livestock in arid and semi-arid regions due to their adaptability and role as sources of meat, milk, and other by-products. Recent studies have emphasized the nutritional advantages of camel meat, emphasizing its high protein content and a favourable amino acid profile compared to other red meats (Mohamed *et al*., 2021). Organ meats, such as heart, liver, and kidney are integral components of traditional diets and are recognized for their dense nutrient composition. However, comprehensive data on their amino acid profiles in camels remain scarce. Previous research has identified leucine as a predominant essential amino acid in both liver and kidney tissues (Abdelrahman *et al*., 2015).

Understanding the amino acid composition of camel offal is crucial for assessing their nutritional value and health benefits. These will aid in dietary recommendations and the development of functional foods, particularly in regions where camels contribute significantly to food security. The study aimed to comparatively evaluate of amino acid profiles of camel heart, liver, and kidney.

MATERIALS AND METHODS
The study was conducted at the Animal Products and Processing Laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria, Kaduna State. Zaria is located in the Northern Guinea Savannah Zone on longitude 11˚09' 01.78''N and 7˚39'14.79''E at an altitude of 671m above sea level. The climate is relatively dry with a mean annual rainfall of 700 -1400 mm (IARMS, 2023).

Samples of 1kg each of red offal (heart, liver and kidney) from camel was obtained from Central Abattoir, Kano. The collected samples were trimmed off connective tissues, fat, debris and dirt; then thoroughly washed. Each separate organ was washed with 150 - 200ml of clean and sterile water, ¼ teaspoonful of salt and 2 teaspoons of lime was also added and used to wash each organ. Cooking by boiling method was used in the processing of the samples. The cut sizes of heart, liver and kidney were read 1 x 2cm each. Also, the three organs were cooked at 120^{0}C at different time ranges (Heart 12mins, Liver 12mins and Kidney 10mins), respectively.

Concentration of proteins was done using Lowry's method while protein estimation was done using Bovin Serum Albumin (BSA) techniques at the Priority Laboratory Services, Jos. Data obtained from the study was statistically analysed using the General Linear Model Procedure of Statistical Analysis Systems software package (SAS, 2002) while significant differences between treatment means was separated using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION
The amino acid profile of red offal from camel is shown in Table 1. The results showed significant (P<0.05) variations in leucine, lysine, methionine, proline, tyrosine, cystine, alanine, glutamic acid, glycine, serine and aspartic acid. The study reveals significant variations in the amino acid profiles of camel liver, heart, and kidney. The liver emerged as the most nutrient-dense organ, particularly for essential amino acids such as leucine, lysine, and methionine. Leucine concentrations were significantly higher in the liver (6.29 g/100g) and heart (6.14 g/100g) compared to the kidney (5.44 g/100g). Leucine is crucial for muscle repair and protein synthesis, suggesting that both liver and heart are excellent dietary sources for individuals requiring high-quality protein intake. These findings align with Mohamed *et al*. (2021), who highlighted the nutritional advantages of camel meat and offal due to their high protein content.

Lysine was highest in the liver (4.73 g/100g), followed by the heart (4.11 g/100g), and was lowest in the kidney (3.11 g/100g). Lysine is an essential amino acid, important for immune function and calcium absorption. Higher level in the liver positions it as a superior source of lysine for promoting immune health and enhancing bone development. Similarly, methionine levels were significantly higher in the liver (2.29 g/100g) and kidney (2.24 g/100g) than in the heart (1.60 g/100g). Methionine is vital for antioxidant defence and methylation processes, highlighting the importance of liver and kidney in diets requiring sulphur-containing amino acids, as supported by Abdelrahman *et al*. (2015).

Table 1: Comparative Evaluation of Amino Acids Profiles of Camel Heart, Liver, and Kidney[U3]

Amino acids (g/100g)	Liver	Heart	Kidney	SEM
Leucine (g/100g)	6.29^{a}	6.14^{a}	5.44^{b}	0.14
Lysine	4.73^{a}	4.11^{a}	3.11^{b}	0.38
Isoleucine	3.09	3.36	3.21	0.17
Phenylalanine	3.45	3.62	3.76	0.22
Tryptophan	0.51	0.34	0.44	0.13
Valine	3.23	3.88	3.63	0.42
Methionine	2.29^{a}	1.60^{b}	2.24^{a}	0.11
Proline	2.23^{b}	3.03^{a}	2.32^{b}	0.12
Arginine	3.85	3.75	3.51	0.19
Tyrosine	3.07^{a}	2.57^{b}	3.11^{a}	0.07
Histidine	2.18	2.38	2.18	0.16
Cystine	0.59^{b}	1.09^{a}	0.71^{b}	0.13
Alanine	3.85^{a}	3.86^{a}	3.12^{b}	0.04
Glutamic acid	10.35^{a}	7.80^{b}	6.86^{c}	0.10
Glycine	3.06^{b}	3.55^{a}	2.72^{c}	0.09
Threonine	2.24	2.84	2.95	0.45
Serine	2.09^{c}	2.82^{b}	3.25^{a}	0.05
Aspartic acid	9.36^{a}	6.29^{b}	6.15^{c}	0.03

^{abc}Means with different superscripts along the same row are significantly ($P<0.05$) different.

Non-essential amino acids like glutamic acid and aspartic acid were most abundant in the liver, with glutamic acid concentrations reaching 10.35 g/100g, significantly higher than in the heart (7.80 g/100g) and kidney (6.86 g/100g). Aspartic acid followed a similar trend. These amino acids are essential for metabolic pathways and neurotransmitter function, further emphasizing the liver's superior nutritional profile. Additionally, the heart exhibited the highest levels of proline (3.03 g/100g), which supports collagen synthesis and skin health, making it valuable for diets targeting joint and tissue repair (Karna *et al.*, 2020). The findings also reveal that cystine content was significantly higher in the heart (1.09 g/100g) compared to the liver (0.59 g/100g) and kidney (0.71 g/100g). Cystine, a precursor to glutathione, plays a crucial role in antioxidant defence mechanisms, reinforcing the importance of camel heart in diets focused on oxidative stress management (Clemente Plaza *et al.*, 2018). Tyrosine levels were comparable between the liver (3.07 g/100g) and kidney (3.11 g/100g), both significantly higher than in the heart (2.57 g/100g). Tyrosine is vital for synthesizing neurotransmitters such as dopamine, supporting its use in cognitive and mood-enhancing diets (Jongkees *et al.*, 2015).

In general, camel liver is a rich source of essential and non-essential amino acids, making it highly suitable for addressing protein and nutrient deficiencies, particularly in arid and semi-arid regions where camels are a staple. More so, the heart, with its elevated levels of proline and cystine, may have applications in functional diets aimed at promoting joint health and antioxidant defence (Lugnier *et al*., 2019). The kidney, while exhibiting moderate amino acid concentrations, remains a valuable nutritional resource with specific strengths, such as its tyrosine content. These findings align with the broader literature on the nutritional importance of organ meats, particularly in regions where dietary diversification is limited. As Mohamed *et al*. (2021) and Abdelrahman *et al*. (2015) have noted, camel offal provides significant dietary value, with the potential for inclusion in food formulations and supplementation programs aimed at improving nutritional outcomes.

CONCLUSION[U4]

The study concludes that camel liver, heart, and kidney are rich sources of essential and non-essential amino acids, with the liver being the most nutrient-dense organ. It is recommended that camel red offal, particularly the liver, be incorporated into food formulations and supplementation programs to enhance dietary protein quality and support health outcomes in regions with limited access to other animal protein sources.

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