NUTRITIVE VALUE OF DIFFERENT ANIMAL PROTEIN SOURCES IN WEANLING WISTAR RATS

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ABSTRACT
The main protein sources human diets include the beef, fish and chickens meat. These sources are often consumed indiscriminately without any regard to their relative nutritive value. Hence, the nutritional quality of different animal protein sources in human and animal diets was assessed in this study, using weanling Wistar rats. Rats (n=25) weighing 30g-40g were randomly allotted to five dietary treatments: T1= Caesin-based diet, T2= Nitrogen-Free diet, T3= Beef-based diet, T4= Catfish-based diet, T5= Chicken breast- based diet in a completely randomised design. The diets were fed to respective weanling rats for four weeks, feed and water were offered ad libitum. Daily urine and faecal samples were weighed, and labelled, then stored at 4oC. Data were analysed using descriptive statistics and ANOVA at α0.05. Rats on T3 had significantly higher ($p<0.05$) feed intake (FI) (48.25) than T4 (43.41) and T5 (22.27). Protein intake was lower significantly ($p>0.05$) in rats on T4 (3.80) Also, rats on T3 (41.01) had higher weight gain than in T4 (23.51), and T5 (15.30). Faecal nitrogen in rats on T3 (2.36), T4 (1.79), and T5 (2.29) were similar ($p>0.05$). The protein efficiency ratio (PER) was significantly higher ($p<0.05$) in T4 (6.07) than in other treatments. The NPR was significantly higher ($p<0.05$) for T1 (3.30), T3 (4.08), and T4 (3.87) than T5 (1.59) and T2 (0.00). The BV was significantly higher ($p<0.05$) for T1 (0.89) than T3 (0.67), T4 (0.58), and T5 (0.68), but significantly lower ($p>0.05$) for T2 (0.12). The NPU values for T3 (75.34), T4 (70.12), and T5 (77.43) were similar ($p>0.05$). Thus, rats on chicken-breast based diets performed best relative to standard casein-based diets.

Keywords: **Wistar rats, Nutritional parameters, Faecal nitrogen. Biological value.**

INTRODUCTION

Proteins, as a class of nutrients, are very essential for humans and other animals (Hermann, 2021). They are one of the building blocks of body tissues and can also serve as a source of fuel. From a nutritional point of view, the most important aspect and the defining characteristic of protein is its amino acid composition (Institute of Medicine, 2005). Proteins are polymer chains, which are made up of amino acids linked together by peptide bonds (Genton et al., 2010). Protein is the major structural component of all cells in the body, including body organs, hair, and skin, when broken down into amino acids, are precursors of nucleic acids, enzymes, co-enzymes, hormones, immune response, cellular repair, and other molecules important for life. Protein is also important in blood formation (Hermann, 2021). Protein occurs in a wide variety of food (Young et al., 1994). Plant protein foods contribute over 60% of the per capita supply of protein supply worldwide (Reynolds et al., 2022). In many parts of the world, insects are a good source of protein (Dobermann, 2017), and in some parts of Africa, up to 50% of dietary protein is derived from insects (Dobermann, 2017). Some other sources of protein include meat, dairy products, egg, soy, fish, legumes, nuts (Young et al., 1994).

The relevance of Wistar rats in assessment of nutritional quality is because of the positive correlation of their metabolism with the human physiological condition and is hinged on the gross similarity of their dietary requirement for essential nutrients (Karen et al., 2022). Differences in performance characteristics could occur, because of disease conditions like malnutrition (Obimba, 2006). Food quality is usually measured in terms of the nutritional or nutritive value (Hoadley and Rowlands, 2014), which is a reflection or measure of the balance of the essential nutrients in food/ feed or diets. Nutritional value of the different proteins varies, and is determined by the amino acid composition, ratio of essential amino acids, and susceptibility to hydrolysis during digestion, source, and the effect of processing. On a biological scale, nutritional value of food or feed may vary for different health

conditions, seasonal differences (Macdiarmid, 2014), age, sexual differences (Alur, 2019), and taxonomic differences. Nutritional indices of prime interest include performance, body weight changes, net protein utilisation, net protein retention, protein efficiency ratio, biological value.
Studies have been carried out on assessment of nutritional value of the different protein sources, in animals (Herreman et al., 2020), however, scanty studies (Mahmoud et al., 2021) have been carried out on the assessment of their relative nutritional value to humans and male weanling Wistar rats. Therefore, this study was aimed at assessing the relative nutritional value of the different animal protein sources in male weanling Wistar rats.

MATERIALS AND METHODS

Experimental site

The study was carried out at the Rat House Facility, in the Department of Animal Science, University of Ibadan, Ibadan, Oyo state, Nigeria. The study area lies between the longitude 7º27.05 N and 3º53.74 of the Greenwich Meridian East, at an altitude of 200m above sea level. The average temperature of the location was 23ºC-42ºC, while the humidity was 60%-80% (SMUI, 2018). Feed preparation was carried out at the Central Nutrition Laboratory, Department of Animal Science.

Experimental Design and Animal Management.

Male weanling Wistar rats (n=25) weighing 30g-40g were purchased for this study and were completely randomly randomized and assigned to the five diets. Each treatment was replicated five times. The rats were individually housed in well ventilated, stainless-steel metabolic cubicle/cages (Multiple Compartment Rack Feature One Cage, Model 1000, England) 0f 0.3m by 0.22m by 1.35m. The cages were set at two layers of six cubicles.
Five different animal-based diets were carefully selected to represent the different animal protein sources. T1-Standard Casein diet, T2- nitrogen-free diet T3-catfish meal diet, T4-chicken breast meal diet, T5-beef meal diet. The rats were fed on respective diets for 28dayss. Urine and faeces were collected from each rat daily, and the collection began from day ten after the commencement of feeding. The collected urine was stored in the freezer at 4ºC daily. Faecal samples were collected, weighed, and labelled daily, and were subsequently oven-dried at 110ºC to a constant weight before analysis. Daily feed intake was recorded across the treatment groups, and the nitrogen analysis of faeces and urine done according to AOAC (2000). The final weight of each rat was recorded. The dietary formulation and composition of diets fed to the rats are shown in Table 1.

Table 1. Composition of the different protein sources-based diets (g/100gDm) fed to the weanling Wistar rats

Treatments	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
	Casein based diet	**Nitrogen-Free Diet**	**Beef based Diet**	**Catfish based Diet**	**Chicken Breast based Diet**
Casein	12.50	0.00	0.00	0.00	0.00
Corn starch	69.00	81.50	70.70	70.60	70.60
Cellulose	5.00	5.00	5.00	5.00	5.00
Soya oil	5.00	5.00	5.00	5.00	5.00
Sucrose	5.00	5.00	5.00	5.00	5.00
Table salt	0.30	0.30	0.30	0.30	0.30
Dicalcium phosphate	2.50	2.50	2.50	2.50	2.50
Calcium carbonate	0.50	0.50	0.50	0.50	0.50
Beef	0.00	0.00	10.80	0.00	0.00
Catfish	0.00	0.00	0.00	10.90	0.00
Chicken breast	0.00	0.00	0.00	0.00	10.90
Vit.-Min Premix	0.20	0.20	0.20	0.20	0.20
Total	**100**	**100**	**100**	**100**	**100**

***Vit.-min premix – Vitamin mineral premix Composition of premix**

Statistical Analysis

Analysis of variance (ANOVA) and descriptive statistics were used to analyse data obtained on faecal and urine samples. Means across groups were separated with the aid of Duncan Multiple Range Tests. Results were expressed as mean ± standard deviation, while the level of significance was at $p \leq 0.05$. All statistical analysis were performed using the Statistical Package for Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA).

RESULTS AND Discussions

Feed Intake, Protein Intake, Weight Gain/Loss and Faecal Nitrogen of Rats fed Different **Experimental Diets**

Effect of different protein sources on performance of the rats are shown in Table 2. Rats on Beef-based diet had higher feed intake, protein intake, faecal nitrogen, and highest weight gain. These suggests that the source of protein in the diet could influence the rats' feed intake and growth and that of the protein sources significantly affected the rats' appetite (Harrold, 2002). The rats fed beef-based diet had higher weight gain, which also suggests that rats on the beef-based diet gained more weight, which is likely due to the higher protein intake in the group. The rats on beef-based diet had higher faecal nitrogen, while those rats on casein diet was lower. Faecal nitrogen is an indicator of the quantity of component amino acid that was not absorbed and utilised by the rats.

Table 2: Feed intake, protein intake, weight gain/loss and faecal nitrogen of rats fed different experimental diets.

Treatments	T1	T2	T3	T4	T5	P-value	SEM
Feed Intake	69.51a	67.16a	48.25b	43.41b	22.27c	0.01	3.99
Body wt.	74.46a	38.56c	72.08a	58.18b	50.37b	0.04	2.97
Protein Intake	10.64a	0.56d	8.22b	3.80c	5.17c	0.02	0.74
Weight Gain	42.88a	7.69c	41.01a	23.51b	15.30bc	0.42	3.10
Faecal Nitrogen	1.62b	1.89ab	2.36a	1.79ab	2.29a	0.12	0.09

SEM: Standard error of mean. Values in the same row with different superscript are significantly different ($P<0.05$)

Biological value of the experimental diets

The biological value of the experimental diets fed to the weanling Wistar rats are shown in Table 3. All the protein sources (T1 to T5) showed positive values for the parameters, indicating that they supported growth and protein utilisation, unlike the protein-deficient control diet (Schroeder and Titgemeyer, 2008). Higher Protein Efficiency Ratio (PER) values indicated a better protein quality. In this study, higher PER value was obtained with the catfish-based diet, which indicated that the protein source supports better growth in rats, compared to other diets. The NPR is a measure of the protein retained to the protein absorbed (Bender and Doell, 1957). Higher NPR values suggest better protein utilisation. The rats on beef-based diet again had higher NPR, which shows that more protein was retained by the rats. The chicken-breast diet had higher BV, indicating that a huge portion of the absorbed protein was of higher quality (Sveier et al., 2001). On the other hand, lower BV was observed in catfish-based diet, suggesting that this protein source was not efficiently utilised by the rats (Odetola and Eruvbetine, 2012).

Table 3: Biological value of the different animal protein source-based diets in weanling Wistar rats

Treatments	T1	T2	T3	T4	T5	P-value	SEM
PER	4.04bc	0.20c	5.02b	6.07a	3.16bc	0.02	0.88
NPR	3.30a	0.00c	4.08a	3.87a	1.59b	0.08	0.38
BV	0.89a	0.12c	0.67b	0.59b	0.68b	0.21	0.21
NPU	82.32a	0.00c	75.34b	70.12b	77.43b	0.01	4.32

PER= Protein Efficiency ratio, NPR=Net Protein Retention, BV=Biological Value and NPU=Net Protein Utilisation, SEM = Standard error of mean. Values in the same row with different superscript are significantly different ($P<0.05$)

CONCLUSION and Recommendation

Rats on chicken breast-based diets had overall best biological value relative to standard casein-based diets. It is recommended that further studies be conducted for in-depth analysis of the amino acid composition of each test ingredients, in order to establish why the diets led to better protein utilisation and efficiency.

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