PERFORMANCE OF LABORATORY RATS ON TAMARIND SEED EXTRACT

BY

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B.Sc (EDUCATIONAL BIOLOGY)

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CERTIFICATION

This Thesis entitled, "PERFORMANCE OF LABORATORY RATS ON TAMARIND SEED EXTRACT", by M.A. IDI, meets the regulations governing the award of the degree of Master of science of Ahmadu Bello University Zaria, and is approved for its contribution to knowledge and literary presentation.

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DECLARATION

I declare that this work is wholly the author's and has not been part of any presentation for any other qualification.

Signed by: Idi, Mercy Aishatu (Mrs)

Date: 30/11/88

DEDICATION

This thesis is dedicated to God who gives me life and strength to do this work, and my sons Idi Mahmuda and Umaru Abdullahi, who were deprived of motherly love and care during the period of my study.

ACKNOWLEDGEMENT

I have to thank Dr Kapu, M.M., of the University of Jos, my first Supervisor, who suggested the area for this research.

I am exceedingly grateful to Dr S. Muazu, of Department of Biological Sciences, who supervised this work. I wish to thank Mr J.O.K., Ansah, Chief Technologist Department of Biological Sciences, Mr. Anche M.S., Assistant Technologist for their assistance during the experiments and Mr Sani Shaka for typing the thesis.

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ABSTRACT

Feeding experiments were conducted to find out if the seeds of the Tamarind tree (Tamarindus indica L) have high quality protein and can promote growth in laboratory rats, so that it can be used in formulation of livestock feeds. Tamarind seed extract contained 19.54% protein.

Four diets were formulated, A, B, C and D. Diet A contained only animal protein (egg white) and diets B, C and D contained tamarind seed extract at 10%, 20% and 30% levels, as well as some egg white at 14.09%, 8.17%and 2.23% levels respectively.

The diets were fed to rats of the age 21-25 days. Weight and length changes were observed for a period of 3 weeks.

Generally the rats fed on diets containing tamarind seed extract had poorer growth and lower protein effeciency ratio (PER) compared to those fed on the diet that contained only egg white. This is as expected.

The best feed conversion ratio (FCR) however, was shown by rats fed on a blended diet (Diet B), which contained a mixture of tamarind seed extract (1.9%) and egg white (14.09%). This showed that there is a need for a balanced diet for food to be properly utilized

by the body.

Although the tamarind protein quality was not specifically determined (in terms of actual amino acid contents) the biological evaluation from this experiment indicates that, it can be mixed in fairly high proportions in the formulation of livestock feeds, provided appropriate animal protein supplements are added.

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ABBREVIATIONS

PER	-	Protein efficiency ratio
FCR	-	Food conversion ratio
g	-	grammes
mm	-	millimetre
%	-	percentage
Wt	-	Weight
SD	-	Standard deviation
Fig.	-	Figure
S	-	Significant
NS	-	Not significant
P	-	Probability
Lth	-	Length
i.e.	-	That is

CHAPTER ONE

1. INTRODUCTION

1.1 Background Information

One of the major problems associated with the development of livestock industries in Nigeria, is the supply of livestock feeds. Over 60% of the production is estimated to be due to the cost of the feed. Isoun (1977).

Herrman (1968) stated that unbalanced diets and particularly lack of protein is the most serious problem facing Nigeria.

Isoun (1977) in a report by Food and Agricultural Development, stated that about 1,600 million people or one is every two of the world's total population are regularly starved of protein particularly animal protein. Nearly 35% of the average North American diet is animal protein, 40% is cereal and 25% vegetables, fruits and other food items. In Asia about 8% animal protein, more than 75% cereal. Nigeria recorded roughly per capital protein intake of 51.7 grams daily out of which 8.6 grams comes from animal sources as against minimum requirement of 35 grams.

The livestock situation in Nigeria has not

improved much in recent times because of lack of basic information on the available feeding stuff. Most of the raw materials for livestock feeds are imported, resulting in high cost of animal protein. This situation has called for the need to survey all potential sources for local raw materials for massive and commercial production of animal feeds. Such a venture will ensure a steady supply of feeds and this will subsidize livestock industries to produce low cost animal protein. Isoun (1977).

The tamarind tree Tamarindus indica L. (Hausa: tsamiya) is a common tree found throughout the tropics and sub-tropics. It grows wild and sometimes it is cultivated. In Nigeria particularly the tree grows wild and is found in the middle belt and the Northern part of the country. The tree can grow in different types of soil: rich loamy, sandy, clayish or dry soil. It can withstand drought and frequent flooding. The tamarind tree is used for different purposes. In Nigeria the leaves and flowers are eaten as vegatables. The pulp is used for making beverage (Hausa: tsimi), flavour for confectionery and for making porridge. The seeds are rarely used, they are more often thrown away as waste. James and Duke (1981).

1.2 Justifucation

Due to the availability and large demand of the tamarind fruits in the Northern part of the country, there is need to evaluate the nutritional value of the seeds, (often thrown away) which can be used as a source of plant protein in making livestock feeds. It may have great potentials to livestock industry.

1.3 Objectives

The aim of this work is: To determine which of the different dietary level of Tamarind seed extract, may promote suitable biological responses such as growth and feed conversion ratio, when fed to laboratory rats.

1.4 Literature Review

Anon (1966) carried out a world wide nutritional survey, which showed that the most prevalent nutritional disease is protein calorie deficiencies. They recommended that all effective means be used to increase food production, especially that of protein source.

This has initiated the scientist concern: the

Agriculturist, Veterinarians, Medical personnel, Biologist to carry out various researches, exploring the seas, deserts, the plant kingdom and other sources, for good quality protein that can be used by man and his animals.

Bender (1978) stated that protein quality is the usefulness of the protein to promote growth and metabolic function.

Aaron (1965) defined growth as the gain in weight. The gain in weight from a better protein would be larger and presumably proportional to the quality of the protein. The gain in weight divide by the amount of food consumed is called protein effeciency ratio (PER). The higher the ratio the better is the protein.

$$\text{PER} = \frac{\text{gain in weight}}{\text{food consumed}}$$

Palne (1967) noted that any difference in growth rate between two individuals of the same species must be due to one either eating more food than the other or utilizing ingested food more effeciently or both. Utilization of ingested food is normally measured by gross growth effeciency which is expressed as a percentage. This is given by the protein effeciency ratio multiply by hundred .

(PER x 100). This indicated a maximum value against which any attempt to improve conversion effeciency could be measured. Instead of this the farmer used feed conversion ratio, which is determined by, the amount of food consumed divided by the weight gain.

$$\text{Feed conversion ratio} = \frac{\text{Food consumed}}{\text{weight gain}}$$

Bressani and Elias (1967) indicated that the protein effeciency ratio varies from crop to crop, and it is the most important criterion in determining the growth rate.

Crampton and Harris (1969) suggested that to evaluate feeds or combination of feeds, live weight gain and feed consumption record can be used. To measure feed consumed, we get gain produced by unit of feed consumed. This should be taken as a method of adjusting the gain for equal feed intake, on the assumption that any differences in gain which remain after such an adjustment is credited to differences in the kind of food.

Palne (1967) stated that better nutrition is a pre-requisite for faster growth. Requirement level should not only be based on some arbitrary fixed standard of growth performance, rather attention should be directed towards a better understanding

of the interrelationship of nutrients, which are used in the formulation of diets, to have a more perfect balance between constituents like amino acids, vitamins, minerals and fatty acids, which are essential for physiological processes in the animal. Mineral elements known as trace elements, such as manganese (Mn) Iodine (I), Cobalt (Co), Copper (Cu), Molybdenum (mo), Zinc (Zn) and others, are essential for the growth and reproductive performances of laboratory rats, Akrabawi et al (1974) study the growth and changes in metabolism of rats fed on carbohydrate deficient fatty acid based diets, supplemented with graded levels of maize, showed that replacement of fatty acids with increasing amounts of maize starch in fatty acid diets, resulted in increase in weight gain.

Abrams (1961) expressed the nutritional requirements of rats and mice in the following terms: Carbohydrates, protein, vitamins, inorganic elements, water, other soluble extract and entibiotics. These could be supplied from a large variety of natural food stuffs, many of which have limited geographical distribution. He indicated that individual food may or may not contain all the necessary nutrients. In the latter case, the missing components are supplemented for.

Bressani and Elias (1967) reported on the amino acid supplementation of Oat protein. They indicated the possibilities that not all the threonine content in this cereal was available in the weanling rats.

Fetuga et al (1976) found that corn flour had the least percentage of crude protein as well as percentage crude fibre, while African locust bean yielded the highest amount of oil. They showed that in maize, lysine and tryptophan are the two limiting amino acids. They indicated a high proportion of lysine in the African locust bean.

Drouliscos and Bowland (1968) performed experiments on the biological evaluation of rapeseed meal, soya bean meal and casein, fed to weanling and matured rats. They found that there was a positive relationship between the various indices and growth; although the relative differences between treatments differed substantially, and the same indices when measured in the matured rats showed an increase over those obtained in the weanling rats. They reported that casein diet was low in methionine.

Budd and Stopp (1967) performed experiments on the nutrition of laboratory animals including rats in relation to growth rate. They proved the need for life and growth, and the evaluation of quantities

of substances contained in natural food. If these substances were not present in the food, the organism lost the abilities of normal assimilation of the nutrient; and could die from hunger, even if there is over supply of food.

Devadas et al (1977) in a biological evaluation study of Raji based diet a low cost indigenous diet mixture, using Albino rats. They discovered that all the three Raji meals supplemented with seed protein were efficient in promoting growth, while the Raji based diet not supplemented with seed protein had the least growth. The efficiency was attributed to the high protein content in the supplemented diets.

Fetuga et al (1978) studied the protein quality of the West African locust-bean seeds, Parkia filcoidea welw. The chemical analysis of the seeds showed that it contained 30.3% crude protein and 12.1% crude fibre. The seeds contained the following amino acids (mg/g protein) 67% Lysine, 6.1% methionine and 8.9% tryptophan. Diets containing 10% crude protein did not support growth in rats which showed that the protein is of poor quality. Utilization of the protein was improved by cooking and removal of the testa of the seeds.

Supplementation with methionine alone resulted

in positive growth and a very substantial increase in protein values. Similarly, supplementation with methionine and tryptophan caused further improvement in protein quality and increased the growth of rats to almost that obtained with whole egg.

Azubuike (1983) investigated the effect of feeding cocoyam and Guinea corn, supplemented with groundnut and snail shell on laboratory rats. He found that both cocoyam and guinea corn based diets promoted growth. There was no significant difference between the growth promoted by the two diets.

Jimeta (1978) investigated the effect of feeding zinc added to groundnut, on growth and distribution of other mineral elements in the tissues of laboratory rats. She found that, whole pod groundnuts, promoted better growth and is superior in maintaining reproduction than those fed on shelled groundnuts.

Gar (1979) compared the performance of rats and mice fed on mice cubes, prepared by "Pfizer Nigeria Limited Kaduna" with diets prepared with groundnut, shelled and unshelled. There was no significant differences in the growth of rats fed on the different diets, prepared from shelled and

unshelled groundnuts. The mice fed on mice cubes grew faster than those fed on shelled and unshelled groundnuts. This shows that each organism has its own basic nutritional requirements.

CHAPTER TWO

2. MATERIALS AND METHODS

2.1 Preparation of Tamarind seed Extract

The tamarind fruits were bought from the local market in Dong and Borong around Numan Local Government, Gongola State of Nigeria.

The seeds were removed by soaking the shelled fruits in cold water for 12 hours. The seeds were squeezed out by gradual rubbing of the sample with two hands.

The seeds were cooked for 8 hours until soft. The cooked seeds were pounded gently to remove the testa. The cotyledons were separated from the testa by washing the sample with water using a sieve. The cotyledons were re-boiled for about 3 hours until soft. The cooked cotyledons were packed warm in a pot and covered with sacks in a warm place and left for 18 hours to ferment. The fermented seeds were sun dried and ground into powder, and designated "Tamarind seed extract".

2.2 Preparation of Starch

Starch was prepared from maize (Zea mays). The grains were soaked in cold water for 24 hours. The soaked grains were then milled into a paste,

which was filtered through a fine mesh sieve. The filterate was allowed to settle, excess water decanted and the residue (starch) was tied in a bag to solidify. The solid starch was cut into pieces and sun dried. The dried starch was milled into powder and designated "STARCH".

2.3 Preparation of Egg White

The egg white used in the formulation of the diets was prepared from fresh raw eggs (chicken eggs). The eggs were boiled and the shell removed. The layers of albumen were removed and dried in an oven at 45°C over night. The dried albumen was blended into powdered form and designated "Egg White".

". Formulation of Diets

Four experimental diets were formulated. A, B, C and D (prepared according to the formulation of Momcilovic and Shah (1976) as recommended by my first supervisor, Dr M.M. Kapu, 1985.

Diet A (the reference diet) contained no tamarind seed extract but 20% egg white, 3% cellulose and 37% detrose.

Diet B, contained 10% tamarind seed extract,

14.09% egg white, 2.4% cellulose and 33.54% detrose.

Diet C, contained 20% tamarind seed extract 8.17% egg white, 1.8% cellulose and 30.03% detrose.

Diet D, contained 30% tamarind seed extract, 2.23% egg white, 1.23% cellulose and 26.54% detrose.

Each diet contained the following nutrients: Groundnut oil 15%, vitamin mixture 1%, mineral mixture 4%, starch 20%, Biotin 0.0004% and zinc as zinc sulphate 0.009%. Each diet makes up to 3,500 grammes by weight.

The entire diet formulation is shown in Table 1.1.

Table 1.1

Percentage Composition of the Diets

Diet/ Ingredients	A g/3500	A %	B g/3500	B %	C g/3500	C %	D g/3500	D %
Egg white	700	20	493	14.09	286	8.17	78	2.23
Tamarind Seed Extract	0 (0	0 0)	350 (68.39	10 1.95)	700 (136.78	20 3.91)	1050 (205.17	30 5.86)*
Cellulose	105	3.0	84	2.4	63	1.8	43	1.23
Detrose	1295	37	1174	33.54	1051	30.03	929	26.54
	Common ingredients making up to 40% of each diet							
	g/3500	%						
Groundnut oil	525	15						
Starch	700	20						
Biotin	0.014	0.0004						
Vitamin mix	35	1						
Mineral mix	140	4						
Zinc sulphate	0.138	9 ug						

Prepared according to the formulation of Momcilovic and Shah (1976) as recommended by my first supervisor, Dr M.M. Kapu (1985).

*Figures in brackets refer to actual protein regarding Tamarind seeds as containing 19.54% protein (Kapu, 1985).

Tamarind seed extract, which is the experimental substance was added at different levels of 0%, 10%, 20% and 30% respectively. As the percentage of the seed extract increases in the diet, that of the egg white decreases, 20%, 14.09%, 8.17% and 2.23%.

The actual protein content of the tamarind seed extract, in each diet is shown in brackets in Table 1.1. For sources of other ingredients used in formulation of the diet see Appendix VII.

2.5 Experimental Procedure

2.5.1 Allocation of Rats to Diets

Twenty weanling rats (Rattus norvigicus), aged between 21-25 days were randomly distributed into four experimental groups of five per diet, irrespective of sex. The animals were housed individually in stainless steel metabolic cages, for 3 weeks, with the diet and water offered ad libitum.

2.5.2 Presentation of Diets to the Rats

Food was presented to each rat in plastic feeding containers. The food was wetted with water and made into small balls to reduce wastage. The animals were test fed with the appropriate experimental diets for five days, to adjust to the diets

and the environment before measurements were taken. The plastic cages, food containers and water bottles were washed weekly, and drinking water changed regularly.

2.5.3 Measurement of Parameters

The initial weights and lengths of the animals were taken before the experimental parameters were taken.

The following parameters were taken weekly between 9.00 a.m. and 12.00 noon, to determine changes in them for the 3 weeks of study.

1. Body weight (grammes)
2. Body length changes (snout to end of tail) (millimeters)
3. Food unconsumed (grammes)
4. Faeces (grammes)

Weekly average body weights and length changes, and food consumed were recorded.

Food consumed is the amount of food used for physiological processes in the body of the animal.

Food consume = Food given less food not consumed and quantity wasted as faeces.

Biological indices such as protein efficiency ratio (PER), feed conversion ratio (FCR) were drawn from

the measurements.

Descriptive statistics such as mean, standard deviation, 't' test, correlation coefficient were employed, to determine any inter-relationships indicating their inter-dependence and the possibilities of explaining what might have occurred in the animals.

CHAPTER THREE

RESULTS

The percentage composition of the diets are shown in table 1.1. The proximate protein content of tamarind seed extract present in each diet is as follows:

Diet A, 0%, Diet B, 1.95%, Diet, C, 3.91%, Diet D 5.86% (See Appendix V, and in brackets in table 1.1).

The total amount of protein present in each diet is shown in Appendix VI: Diet A, 20%, Diet B, 16.04%, Diet C 12.08%, Diet D, 8.09%.

The observed weights and lengths of rats over the period of experimentation are shown in Appendix III.

The weekly weight gains and mean weight changes of rats on the diets were shown in table 3.1. Rats fed on diet A had the highest mean weight gain of 5.65g, followed by rats fed on diet C 4.79g, B 4.76g and D 0.29g respectively. Rats fed on diet A grew better than rats fed on the other diets, while rats fed on diet D had the poorest growth.

Statistical analysis of mean weight changes showed that there were no significant differences between the rats fed on diets A and B ($P = 0.40 - 0.45$), A and C ($P = 0.40-0.45$), A and D, ($P = 0.05-0.10$), B and C ($P = 0.5$), and B and D ($P = 0.1 - 0.5$). The difference between diet C and D ($P = 0.025 - 0.05$) is barely significant. Table 3.2.

Table 3.1

Weight changes (g) of Rats for 3 Weeks of Study.

Diet	Rat No	Pre Expt wt (g)	Week 1	Week 2	Week 3	Total wt changes(g)	Mean weekly wt changes (g)
	1	43.43	3.67	1.05	7.8	12.52	4.17
	2	30.08	-1.93	1.69	5.51	5.27	1.76
	3	30.68	15.87	6.8	-9.7	12.97	4.32
A	4	48.03	21.22	9.05	-8.8	34.47	11.49
	5	39.08	2.82	10.54	6.21	19.57	6.52
Mean		38.39	9.53	5.83	1.60	16.96	5.65
	1	50.38	8.47	7.75	2.6	18.82	6.27
	2	46.68	16.97	1.88	-0.28	18.57	6.19
	3	34.48	-1.78	-8.55	18.0	7.67	2.56
B	4	37.48	2.89	-6.37	-1.8	-5.28	1.76
	5	57.45	12.9	10.55	8.15	31.6	10.39
Mean		45.29	7.89	1.05	5.33	14.27	4.76
	1	35.98	6.67	4.4	9.1	20.17	6.72
	2	38.78	-0.73	0.4	1.45	1.12	0.37
	3	41.08	13.17	11.6	3.1	27.87	9.29
C	4	51.95	3.0	-0.15	3.4	6.25	2.08
	5	52.28	8.12	5.9	2.45	16.47	5.49
Mean		44.01	6.05	4.43	3.9	14.38	4.79
	1	34.98	-12.08	2.05	0.7	-9.33	-3.11
	2	33.38	-0.28	-2.99	-0.44	2.27	0.76
	3	41.69	1.48	2.51	0.27	4.26	1.42
D	4	39.58	0.07	5.0	-1.7	3.37	1.12
	5	32.58	2.75	0.4	0.6	3.75	1.25
Mean		39.91	-1.61	2.59	-0.11	0.87	0.29

Table 3.2

Statistical analysis of mean weekly weight gains of rats for 3 weeks of study

Diets	Mean	SD	't' Value	Significance
A and B	5.65 4.76	3.97 3.45	0.21	P= 0.40-0.45 NS
A and C	5.65 4.79	3.97 1.12	0.25	P= 0.40-0.45 NS
A and D	5.65 0.29	3.97 2.13	1.44	P= 0.05-0.10 NS
B and C	4.76 4.79	3.45 1.12	0.01	P= 0.5 NS
C and D	4.79 0.29	1.12 2.13	2.3	P= 0.025-0.05 "barely" significant
B and D	4.76 0.29	3.45 2.13	1.35	P= 0.10-0.15 NS

Key: Level of significance = (P = 0.05)
NS = Not significant
BS = Barely significant
Degree of freedom for all the 't' values is 8.

Table 3.3

Feed Conversion Ratio (FCR) of Rats for 3 Weeks of Study.

Diet	Rat No	Total Wt gained(g)	Total food consumed	FCR	SD
A	1	12.52	81.55	6.51	3.71
	2	5.07	69.22	13.65	
	3	12.97	99.03	7.64	
	4	34.47	140.13	4.07	
	5	19.57	015.29	5.38	
	Mean	16.92	99.04	7.45	
B	1	18.82	108.88	5.79	11.90
	2	18.57	124.41	6.70	
	3	7.67	70.87	9.24	
	4	-5.28	104.24	19.74	
	5	31.16	146.6	4.70	
	Mean	14.19	111.0	1.34	
C	1	20.17	135.47	6.72	30.30
	2	1.12	84.14	75.13	
	3	27.87	138.23	4.96	
	4	6.25	106.18	16.99	
	5	16.47	77.0	4.68	
	Mean	14.38	108.20	21.70	
D	1	-9.33	74.2	-7.95	18.01
	2	2.27	90.98	40.08	
	3	4.26	87.72	21.06	
	4	3.37	98.38	29.19	
	5	3.75	99.6	26.56	
	Mean	0.86	90.18	21.79	

Table 3.4

Statistical Analysis of Mean FCR of Rats for 3 weeks of study.

Diet	Mean	SD	't' value	Significance
A and B	7.45 1.34	3.71 11.90	0.78	P = 0.20-0.25 NS
A and C	7.45 21.70	3.71 30.30	0.77	P=0.20-0.25 NS
A and D	7.45 21.79	3.71 18.01	1.23	P=0.10-0.15 NS
B and C	1.34 21.70	11.90 30.30	1.03	P=0.15-0.20 NS
C and D	21.70 21.79	30.30 18.01	0.004	P= 0.5 NS
B and D	1.34 21.79	11.90 18.01	0.75	P=0.20-0.25 NS

Key: Level of significance (P = 0.05)
NS = Not significant
Degree of freedom for all the 't' value is 8.

Table 3.5

Protein efficiency ratio (PER) of Rats for 3 Weeks of Study

Diet	Rat No	Total Wt gained (g)	Total Feed consumed (g)	PER	SD
A	1	12.52	81.55	0.15	0.07
	2	5.07	69.22	0.07	
	3	12.97	99.03	0.13	
	4	34.47	140.13	0.25	
	5	19.57	105.29	0.19	
	Mean	16.96	99.04	0.16	
B	1	18.82	108.88	0.17	0.10
	2	18.57	124.41	0.15	
	3	7.67	70.87	0.11	
	4	-5.28	104.24	-0.05	
	5	31.16	146.6	0.21	
	Mean	14.19	11.0	0.12	
C	1	20.17	135.47	0.15	0.09
	2	1.12	84.14	0.01	
	3	27.87	138.23	0.20	
	4	6.25	106.18	0.06	
	5	16.47	77.0	0.21	
	Mean	14.38	108.20	0.13	
D	1	-9.33	74.2	-0.13	0.07
	2	2.27	90.98	0.02	
	3	4.26	87.72	0.05	
	4	3.37	98.38	0.05	
	5	3.75	99.6	0.04	
	Mean	0.86	90.18	0.002	

Table 3.6

Statistic Analysis of Mean PER of Rats for 3 weeks of study

Diet	Mean	SD	't' value	Significance
A	0.16	0.02		
and			4.0	P=0.0005-0.0025
B	0.12	0.10		S
A	0.16	0.07		
and			0.4	P = 0.35
C	0.13	0.09		NS
A	0.16	0.07		
and			2.4	P=0.0125-0.025
D	0.002	0.07		S
B	0.12	0.10		
and			0.1	P=0.45-0.47
C	0.13	0.09		NS
C	0.13	0.09		
and			1.8	P=0.05-0.10
D	0.002	0.07		NS
B	0.12	0.10		
and			1,3	P=0.10-0.15
D	0.002	0.07		NS

Key: Level of significance (P = 0.05)
NS = Not significant
S = Significant
Degree of freedom for all the 't' values is 8.

The feed conversion ratio (FCR) of the rats were given in Table 3.3. Rats fed on diet B had the best feed conversion ratio of 1.34, followed by rats fed on diets A 1.45, C 21.70 and D 21.79 respectively. Rats fed on diet B ate the least food, while those fed on other diets ate more food to increase their weights. Lower feed conversion ratio, showed better utilization of food in the body of the animal.

Statistical analysis of feed conversion ratio showed that there were no significant differences between rats fed on all the diets. A and B ($P = 0.20 - 0.25$), A and C ($P = 0.20-0.25$), A and D ($P = 0.10 - 0.15$), B and C ($P = 0.15-0.20$), C and D ($P = 0.5$) and B and D ($P = 0.20-0.25$). Table 3.4.

Protein efficiency ratio (PER) is given in Table 3.5. Rats fed on diet A had the best protein efficiency ratio of 0.16, followed by those fed on diet C, 0.13, B, 0.12 and D, 0.002 respectively.

The higher the protein efficiency ratio the better is the quality of the protein.

Statistical analysis of protein efficiency ratio showed that there were no significant differences between rats fed on diets A and C

(P = 0.35), B and C (P = 0.45-0.47), C and D (P = 0.05 - 0.10) and B and D (P = 0.10-0.15).

Differences were shown by rats fed on diets A and B (P = 0.0005-0.0025) and A and D (P = 0.0125-0.025). (Table 3.6).

The differences between diet A and B and A and D showed that the protein in diet A is of a better quality than that found in diets B and D.

Table 3.7

Correlation Coefficient of the Mean Weights (g) and Lengths (mm) Changes of the Rat on Diets.

Diet	Rat	Mean Wt changes(g)	Mean Lth. changes(mm)	Correlation Coefficient 'r' level	Significance
A	1	4.17	5.33	0.92	P=.02-05 'S'
	2	1.69	1 .67		
	3	4.32	5.0		
	4	11.49	8.33		
	5	6.52	6.62		
B	1	6.27	7.33	0.82	P= .05-10 'NS'
	2	6.19	9.33		
	3	2.56	5.33		
	4	-1.76	5.00		
	5	10.38	8.33		
C	1	6.72	15.0	0.50	P= .10 'NS'
	2	0.37	5.33		
	3	9.29	8.33		
	4	2.08	6.67		
	5	5.49	5.67		
D	1	-3.11	7.67	-0.09	P= .10 'NS'
	2	0.76	6.17		
	3	1.42	8.33		
	4	1.12	7.33		
	5	1.25	7.33		

Key: Level of significance (P= 0.05)
NS = Not significant
S = Significant
Degree of freedom is 3.

The pre-experimental body weights and lengths of the rats fed on each diet is shown in appendix I. The mean weight changes and increase in lengths of the rats fed on the diets were compared (table 3.7). The 'r' level of rats fed on diets A = 0.92, B 0.82, C 0.50, and D -0.09.

Statistical analysis showed that there was significant correlation of weight and length changes of rats fed on Diet A (P = .02-.05). The correlation of weight and length changes of rats fed on Diets B, C and D were not significant. The P values are respectively. 0.05-0.10, >.10 and >.10.

Diet D showed a negative correlation. This shows that changes were on an inverse direction.

The mean cumulative growth rate of rats fed on the diets were plotted in fig. 3.1. The graph showed that rats fed on diet A had the best growth, followed by C, B and D respectively.

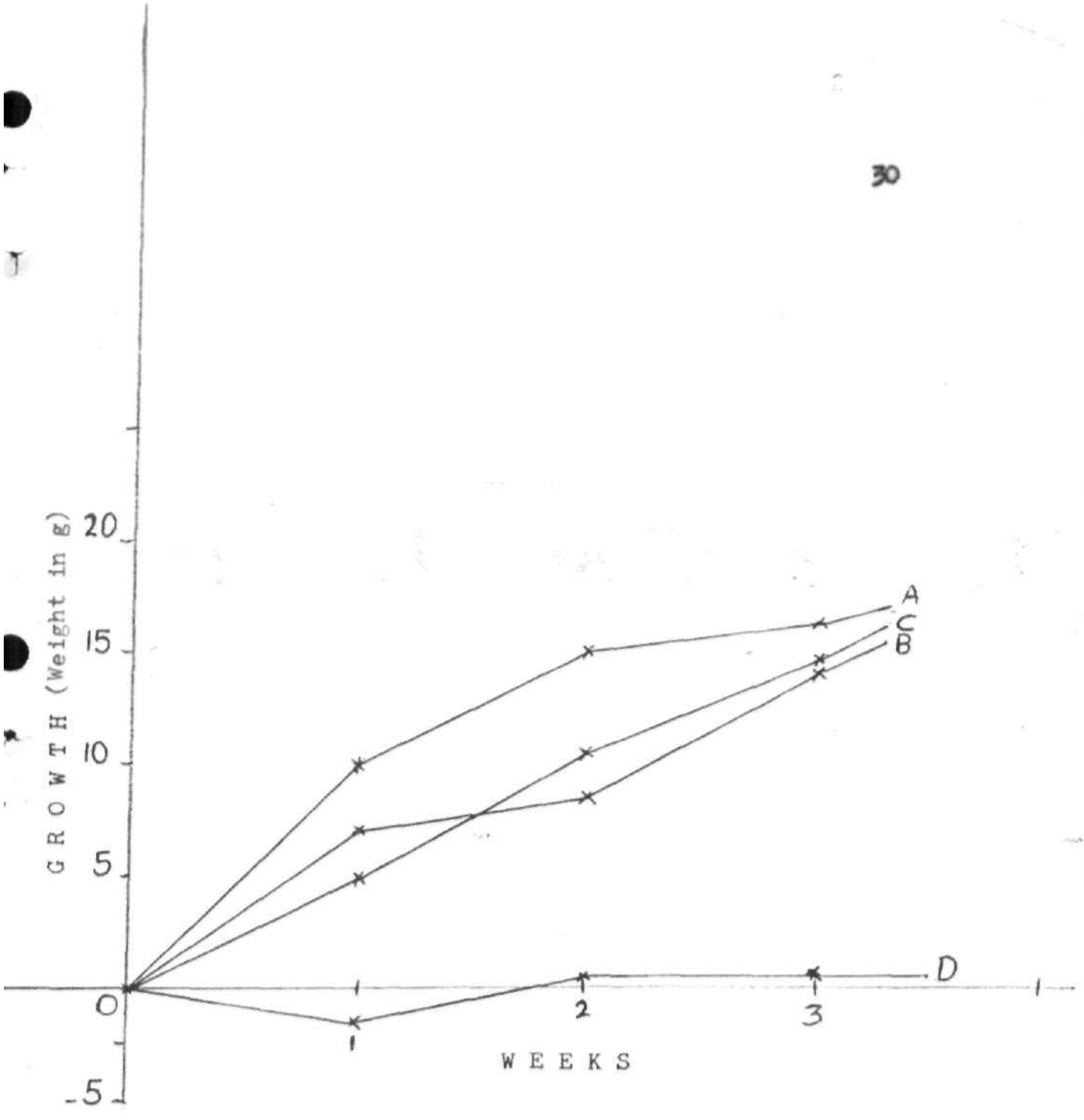


FIG. I Mean cumulative growth of Rats on diets A,B,C and D.

CHAPTER FOUR

DISCUSSION

The growth rate of rats fed on diet A which contained only animal protein (egg white) was better than that of rats fed on diets B, C and D, which contained a combination of animal protein (egg white) and plant protein (tamarind seed extract).

Animal proteins have complete Amino acids and are easily digested thus have high protein efficiency ratio (PER) and better feed conversion ratio (FCR), while plant proteins have incomplete Amino acids and are not easily digested thus have low protein efficiency ratio (PER) and poor feed conversion ratio (FCR) (Aaron 1965).

The amount of animal protein (egg white) used in diet A (20%) was higher than the amount used in other diets, B 14.09%, C 8.17% and D 2.23%, considering the fact that egg white has a better feed conversion ratio, Diet A is expected to promote the best growth in comparison to other diets, where the amount of egg white decreases. Ideally supplementation with tamarind should maintain the total protein content of all the four diets at 20%. However, since tamarind extract contains only 19.54% protein (Kapu 1985), the amounts added to replace egg white

protein only had the effect of lowering the final protein concentrations from 20% (Diet A) to 16.04% (Diet B) 12.08% (Diet C) and only 8.09% (Diet D) Appendix III. This is because the amounts of tamarind added were based on similar amounts of rapeseed which however had higher protein content than tamarind seeds.

As mentioned above the method of diet formulation used has the effect of lowering the absolute protein content as more tamarind extract is used. The effect of the diets on growth must therefore be due to both protein quality and quantity.

If a hypothetical mean weight change is calculated, based on twenty percent protein (20%) in each diet, the following results would be obtained.

Hypothetical mean weight change per 20% protein =

$$\frac{\text{actual mean}}{\% \text{ protein}} \times \frac{20}{1}$$

Diet	Protein Quantity(%)	Mean weight change(g)	Hypothetical mean weight per 20% protein
A	20.00	5.65	5.65
B	16.04	4.76	5.94
C	12.08	4.79	7.93
D	8.09	0.29	0.72

If the same quantity of 20% protein was given in all the diets, the mean weight gains of the rats would increase as shown above, Diet A (5.65g), Diet B

(5.94g), Diet C (7.93g) and Diet D (0.72g). The best performance would be given with diet C containing 8% egg white and 20% tamarind extract. In diet D however, the protein quality is now the limiting factor (2.0% egg white, 30% tamarind extract) and the mean weight gain is much reduced.

Since the two types of protein present in the diets were not inter-changed in the right proportions, the quality of the proteins cannot be assessed. The diets containing tamarind seed extracts resulted in poor growth, poor PER, because of low amount of protein in the diets not necessarily due to the quality of the proteins in the diets.

Aaron (1965) defined growth as the gain in weight. The gain in weight from a better protein would be larger and proportional to the quality of the protein.

The protein efficiency ratio of rats fed on diet A was higher than those fed on diets B, C and D. The higher the protein efficiency ratio the better is the protein. This showed that the quality of protein in diet A was better than that in diets B, C and D. (Table 3.5).

Statistical analysis of protein efficiency ratio showed that there was significant difference between

diet A and B (P = 0.0005 - 0.0025) and A and D (P = 0.0125 - 0.025) Table 3.6. Diet A contained only egg white, while diets B and D contained a mixture of egg white and tamarind seed extract, tamarind seed extract being a plant protein might have lowered the quality of the diets.

The feed conversion ratio of rats fed on diet B was better than those fed on diets A, C and D. (B; 1.34, A; 7.45, C; 21.70, D; 21.79). Diet B contained 14.09% egg white and 10% tamarind seed extract (1.95% protein quantity per gramme composition).

Carlson (1948) said that for an organism to grow well it needs an optimum diet, which permits and promotes optimum growth, developments and all further biological functions.

Fetuga et al (1978) found that when poor quality

protein was supplemented with essential amino acids, it improves the quality of the protein and increases the growth rate to almost that obtained with whole egg. From Fetuga's work it shows that, whole egg gave the best growth and contained a high quality protein.

Palne (1967) found that in formulation of diets there is need for a perfect and balanced constituents of amino acids, vitamins, minerals and fatty acids for proper physiological processes needed by animals.

Tamarind seed extract is a plant protein, which have incomplete amino acids and is of poor quality, when added to the diets, it was supplemented with some amount of egg white to improve the quality of the diet. Diet B had the best FCR (1.34) (Table 3.3), this showed that the constituent of diet B was better utilized by the body. A blend of animal and plant protein in a right proportion, will result to a well balanced diet, resulting in faster growth. Even if tamarind seed extract is of poor quality if properly supplemented with a high quality protein in the right proportion, it can bring about increase in weight.

There was simultaneous correlation of the weight and length of the rats feed on all the diets. Growth

results to total increase in the size of the body, if there is retardation, it will also affect the whole body as shown by rats fed on diet D, that showed a negative correlation coefficient.

CONCLUSION

Although Tamarind seed extract has high protein content (19.54%), it will have to be supplemented with high quality protein to promote growth. The best feed conversion ratio was given by diet B, which contained 14.09% egg white and 1.95% tamarind seed protein. Although the percentage content of protein is lower than that of diet A, still it gave the best FCR. (Diet A 20% and Diet B 16.04%). This shows that a well balanced diet is important in formulation of diets. If a diet is balanced it is properly utilized by the body.

Reay (1979) noted that differences in growth rate between two individuals of the same species must be due to one either eating more food or utilizing ingested food more efficiently or both. In this experiment although rats fed on diets C and D took more food, it was not properly utilized/probably due to unbalance between the nutrients and the low protein content of the diets. And diet A had a high protein content but not properly utilized as diet B.

The protein quality of tamarind seed may be low and possibly due to some anti nutritional factors, only a little amount can be added to a diet.It is recommended that tamarind seeds should be used provided the right amount is added to balance the diet when formulating livestock feeds.

It is possible however, the individual species differences may give different results with tamarind extract and such species for which the feeds are designed to be test fed, instead of using laboratory rats. Also the results obtained in this experiment may not be statistically conclusive, due to the small scale based on small sample (5 rats) which were fed on each diet.

Other leguminous seeds, of lower protein content, in combination with the tamarind seeds extract can be tried for better results.

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Appendix I

Pre-experimental Body Wts (g) and Length (mm) of the Rats

Diet	Rat	Body Wt (g)	Body Length (mm)
A	1	43.43	215
	2	30.08	175
	3	30.68	205
	4	48.68	235
	5	39.08	205
	Mean	38.39	207
B	1	50.38	238
	2	46.68	223
	3	34.48	195
	4	37.48	190
	5	57.45	225
	Mean	45.29	214
C	1	35.98	180
	2	38.78	220
	3	41.08	190
	4	51.95	235
	5	52.28	258
	Mean	44.01	216.6
D	1	34.98	172
	2	33.30	185
	3	41.69	195
	4	39.58	180
	5	50.0	220
	Mean	39.91	190.4

Appendix II

Length changes and final length gain (mm) of Rats

Diet	Rat No	Pre Exper. Length (mm)	WEEKS 1	2	3	Total Length gain (mm)	Mean Length gain
A	1	215	15	0	1	16	5.33
	2	175	3	0	2	5	1.67
	3	205	3	6	6	15	5.0
	4	235	13	7	5	25	8.33
	5	205	5	13	2	20	6.67
B	1	238	4	5	13	22	7.33
	2	223	7	5	16	28	9.33
	3	195	5	0	11	16	5.33
	4	190	10	5	0	15	5.0
	5	225	13	7	5	25	8.33
C	1	180	15	20	10	45	15.0
	2	220	8	3	5	16	5.33
	3	190	8	7	10	25	8.33
	4	235	9	6	5	20	6.67
	5	256	6	6	5	17	5.67
D	1	172	8	10	5	23	7.67
	2	185	7	8	5	20	6.17
	3	185	10	10	5	25	8.33
	4	180	7	13	2	22	7.33
	5	220	10	6	6	22	7.33

Appendix III

Weekly Body Weights (g) and Length (mm) of Rats

Diet	Rat No	1 Wt	Lth	2 Wt.	Lth	3 Wt.	Lth
A	1	47.1	230	48.15	230	55.95	231
	2	28.5	178	29.84	178	35.15	180
	3	46.55	208	53.35	214	43.65	220
	4	75.9	248	84.95	255	83.15	260
	5	41.9	210	52.44	223	58.65	225
B	1	58.85	242	66.6	247	69.20	260
	2	63.65	230	65.53	235	65.25	251
	3	32.7	200	24.15	200	42.15	211
	4	40.37	200	34.0	205	32.20	205
	5	70.35	238	80.90	245	89.05	250
C	1	42.65	195	47.05	215	56.15	225
	2	38.05	228	38.45	231	39.90	236
	3	54.25	198	65.85	205	68.95	215
	4	54.95	244	54.8	250	58.20	255
	5	60.4	264	66.30	270	68.75	275
D	1	22.9	180	24.95	190	25.65	195
	2	33.1	192	36.09	200	35.65	205
	3	43.17	195	45.68	205	45.95	210
	4	39.65	187	44.65	200	42.95	202
	5	52.75	230	53.15	236	53.75	242

Appendix IV

Foof (g) consumed by Rats on Diets during 3 Weeks of Study period

Diet	Rat No	WEEKS			Total Food consumed
		1	2	3	
A	1	32.05	14.71	35.79	81.55
	2	28.73	16.65	23.84	69.22
	3	46.98	30.54	21.51	99.03
	4	49.62	39.42	31.09	140.13
	5	40.83	32.77	31.69	105.29
B	1	42.67	35.82	30.39	108.88
	2	61.6	29.28	33.53	124.41
	3	35.31	14.34	21.22	70.87
	4	50.08	23.39	30.77	104.24
	5	54.8	44.95	46.85	146.6
C	1	53.31	35.08	47.08	135.47
	2	30.48	28.68	24.98	84.14
	3	50.18	42.12	45.93	138.23
	4	39.18	26.76	40.24	106.18
	5	24.44	38.0	14.56	77.0
D	1	25.95	20.03	28.22	74.2
	2	37.38	26.8	26.8	90.98
	3	24.89	31.93	32.9	89.98
	4	43.39	28.84	26.15	98.38
	5	31.91	35.15	32.54	99.6

Appendix V

Composition of Protein in Diets

Tamarind seeds contain 19.54% crude protein (Kapu (1985), Personal Communication).

100g = 19.54g of protein

Diet B = 10% tamarind seed concentrate

$$10\% \text{ of } 3500g = \frac{10}{100} \times \frac{3500}{1} = 350g$$

$$350g = \frac{19.54}{100} \times \frac{350}{1} = 68.39g$$

$$68.39g = \frac{68.39}{3500} \times \frac{100}{1} = 1.954\%$$

Diet B contain 68.39g protein

= 1.95%

Diet C = 20% of tamarind seed concentrate

20% of 3500g = 700g

$$700g = \frac{19.54}{100} \times \frac{700}{1} = 136.78g.$$

$$136.78g = \frac{136.78}{3500} \times \frac{100}{1} = 3.91\%$$

Diet C contain 136.78g of protein = 3.91%

Diet C = 30% tamarind seed concentrate

30% of 3500g = 1050g

$$1050g = \frac{19.50}{100} \times \frac{1050}{1} = 205.17g$$

$$205.17g = \frac{250.17}{3500} \times \frac{100}{1}$$

Diet D contain 205.17g of protein = 5.86%.

Appendix VI

Total Amount of protein present in each Diet.

Diet A contained only egg white

= 20%

Total = 20%

Diet B contained

Egg white = 14.09%

tamarind seed extract = 1.95%

Total 16.04%

Diet C contained

Egg white = 8.17%

tamarind seed extract = 3.91%

Total = 12.08%

Diet D contained

Egg white = 2.23%

tamarind seed extract = 5.86%

Total = 8.09%.

Appendix VII

Source of Ingredients used in formulation of the 1 diets.

Cellulose (acetate) from (BDH) chemical Ltd. Broom Road, Parkstone, Poole England.

Detrose (D - glucose 'AnalaR') from (BDH) chemical Ltd. Broom Road, Parkstone, Poole England.

Biotin from (BDH) chemical Ltd. Broom Road, Parkstone, Poole England.

Vitamin Mixture from Poultry Feed Unit, Arewa farms, Zaria, Nigeria.

Mineral Mixture from Poultry feed unit, Arewa Farms, Zaria, Nigeria.

Zinc sulphate from (BDH) Chemical Ltd., Broom Road, Parkstone, Poole England.

Groundnut oil from market, Samaru, Zaria, Nigeria.