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Protein Supplements Utilization and Their Effects on the Growth, Reproductive Capacity and Offspring Birth Weights of the Laboratory Rat, *Rattus norvegicus*

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Abstract: One hundred and twenty six laboratory rats, *Rattus norvegicus* (63 males and 63 females) were used in a 5 months trial to study the effects of dietary supplements on the growth, reproductive capacity and offspring birth-weights of the rats. The rats were randomly distributed into 7 dietary groups tagged dietary A (poultry starter mash+groundnut cake meal), dietary B (poultry starter mash+prawn meal), dietary C (poultry starter mash+soyabean meal), dietary D (poultry starter mash+fish meal), dietary E (poultry starter mash+groundnut meal), dietary F (poultry starter mash+blood meal) and dietary G, the control (poultry starter mash only). The highest weight gain was obtained by male rats fed with diet D (45.66 g) while the least weight was observed in male rats fed with diet F (26.98 g). Female rats fed with diet B had the longest tail length (18.40 cm) while male rats fed with the same diet recorded 16.10 cm. The highest number of offspring (7) were produced by female rat fed on diet D. The average birth-weight of the offspring was 3.56 g. The offspring of the rats fed with diet A had th highst birth-weight (4.36 g).

Key words: *Rattus norvegicus*, reproductive capacity, foetus, birth-weight, under-utilized, phytochemicals

INTRODUCTION

Food is very important to living organisms. Despite having the genetic basis that may condition adequate growth, the ultimate size of an animal is also influenced by its environmental stimulus such as nutrition (Prader *et al*., 1963; Damrich, 1991). Lack of adequate quantity of protein in the diets of animals have been reported to lead to diseases and malfunctioning of the body systems. Many studies have shown that insurfficient levels of dietary protein inhibit growth and therefore cause delay in attaining puberty and also in the time taken for animals to reach full adult size (Damrich, 1991; Yayha and Milward, 1994; Cameron and Eshelman, 1996). Park *et al.* (1987) reported that the imposition of excessive dietary restrictions on growing animals can cause growth retardation and also negatively affect physiological function such as lactation in female animals.

The ultimate goal of any livestock industry is the attainment of sustainable livestock production with minimum costs in the shortest time possible (Eruvbetine *et al*., 2002). This has led to the trial of various protein supplements as possible replacements for the conventional proteins used in the preparation of livestock feeds. Moreover, the high cost of fish and other sources of animal protein have compelled researchers to consider other under-utilized sources of protein as replacements for the much needed proteins in the diets of livestock. Thus, another unconventional protein source being considered in recent times are the arthropods. Arthropods are insect groups that are known to be rich in crude protein and minerals (Aduku, 1993; Ojewola *et al*., 2003; Ogunleye and Omotoso, 2005).

MATERIALS AND METHODS

Collection rats and preparation of feeds: Three weeks old laboratory rats, *Rattus norvegicus* used for the experiments were obtained from the Department of Biochemistry, University of Ilorin in Kwara State, Nigeria. One hundred and twenty six rats containing 63 males and 63 females were randomly distributed into seven dietary cages labeled cages A-G. Each dietary cage contained 3 male and 3 female rats. Each dietary cage was triplicated. The rats were kept in cages in the laboratory. The poultry starter mash used for the experiments were obtained from Agricultural Input and supply unit of Ekiti State Ministry of Agriculture in Ado-Ekiti, Ekiti State of Nigeria. The protein supplements used for the work included groundnut meal, groundnut cakes, soyabean meal, under-utilized prawn discards, under-utilized fish discards and blood meal. All these materials

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Table 1: Different dietary compositions fed to the rats

Dietary cages	Composition
Dietary group A	Poultry starter mash+groundnut cake meal
Dietary group B	Poultry starter mash+prawn meal
Dietary group C	Poultry starter mash+soyabean meal
Dietary group D	Poultry starter mash+fish meal
Dietary group E	Poultry starter mash+groundnut meal
Dietary group F	Poultry starter mash+blood meal
G (control)	Poultry starter mash only

were obtained from Okesa Market in Ado-Ekiti. Each of the supplement was sun-dried separately and pulverized into powdery form with pistle and mortar and kept in air-tight bottles in the laboratory. Blood was collected from Atikankan Abbattoir in Ado-Ekiti. The blood put in bags and cooked with pots on an electric stove for 1 h. The blood was allowed to cool and it was sun-dried for 72 h before being pulverized with pestle and mortar. It was stored in air-tight bottles in the laboratory.

Growth and reproductive performances assays: The initial weights of the rats, *Rattus norvegicus* used for the work were weighed with an electric analytical weighing balance in the laboratory. The weight of an empty box was taken and each rat was put in the box to determine its weight. The length of the tails of the rats were taken with threads and the treads were later spread on a meter rule to determine its actual measurement. The rats were given diets that form 40% of their body weights together with 15 g of protein supplements on daily basis (Table 1). One litre of water was given to the rats in each cage daily. In the control experiment, only starter mash was given to the rats. The weights and the length of the tails of the rats were taken every fortnight. The experiments were monitored for 5 months.

RESULTS AND DISCUSSION

The result of the weights of the laboratory rats, *Rattus norvegicus* is presented in Fig. 1. The male rats fed with diet D (fish meal) recorded the highest weight increase of 45.66 g while female rats fed with the same diet recorded 45.54 g. They were closely followed by the rats fed with diet F (prawn meal) which recorded 43.53 g for male while the female recorded 43.02 g. Omotoso and Sanya (2007) reported that prawn discard is one of the best protein supplements which can replace fish in livestock feeds. Ojewola and Udom (2005) has detemined the nutrient compositions of some unconventional animal protein sources which may be used as good replacements for animal proteins in livestock feeds. The male rats fed with diet A (groundnut cake) recorded weight gain of 40.86 g while the female rats recorded 34.48 g weight gain. The male rats fed with diet C (soyabean) recorded weight

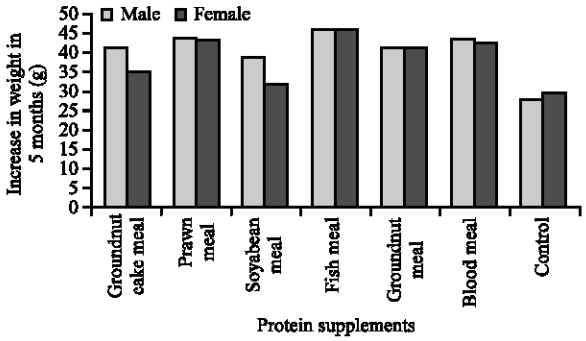

Fig. 1: Effect of protein supplements on growth performances of Norway rats, *Rattus norvegicus* in 5 months

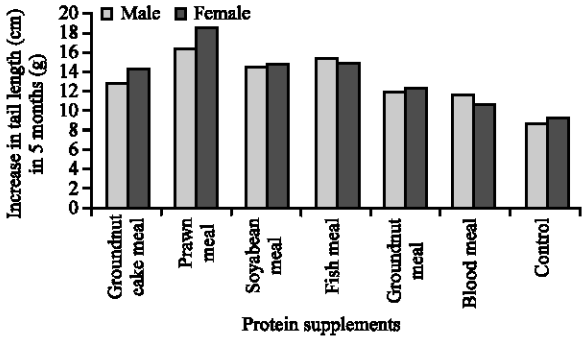

Fig. 2: Effect of supplementary proteins on the length of tails of the laboratory rats, *Rattus norvegicus* in 5 months

gain of 38.66 g while female rats recorded 31.26 g weight gain. The demand for high protein in animal feedstuffs have prompted considerable interest in the development of marine organisms, arthropds and their by-products (Agunbiade *et al*., 2004; Oduguwa *et al*., 2004; Ojewola and Udom, 2005). The National Research Council (1978) reported that a diet containing 12% net protein and approximately 14% crude protein is adequate for the growth and maintenance of rats. However, the most commonly used rodent diets contained approximately 19-27% protein (Rao and Knapka, 1998; Kemi *et al*., 2000). Ghanta (2002) reported that high protein is the major cause of severe nephropathy (i.e. protein-overload nephropathy). Changing the source of protein to one such as soy protein, restricting caloric intake, or modifying the diet to decrease protein consumption could decrease the severity of nephropathy (Ghanta 2002). Soyabean is a suitable replacement for fish meals in the diets of animals in developing and developed countries of the world because of the dwindling fish resources from oceans and the high prices of fish meal. Soyabean meal as a protein supplement has been used with varying success

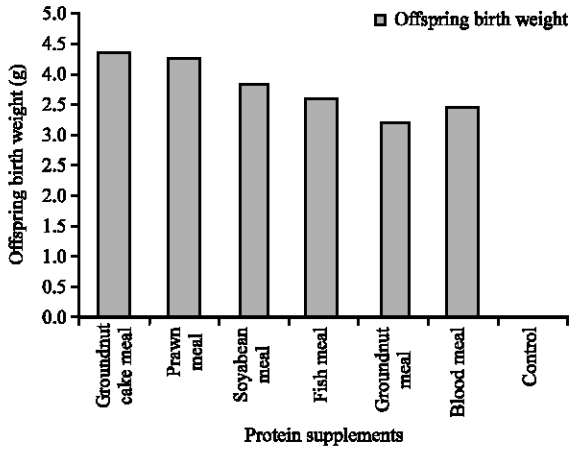

Fig. 3: Effects of supplementary proteins on offspring birth weights of the laboratory rats, *Rattus norvegicus*

in the diets of several fish species such as the African catfish (Balogun and Ologhobo, 1989). The lowest weight increase was observed in the control diet (i.e. diet G) where male and female rats recorded 26.98 and 28.75 g, respectively.

The results of the effects of different types of dietary supplements on the length of the tails of rats, *Rattus norvegicus* is presented in Fig. 2. Female rats fed with diet B recorded the longest tail length of 18.40 cm while male rats recorded 16.10 cm. They were closely followed by the male and female rats in diet D which recorded tail length of 15.10 and 14.90 cm, respectively. Female rats fed with diet C recorded tail length of 14.75 cm while male rats fed on the same diet recorded 14.55 cm. In the control, female rats recorded 9.20 cm while male rats recorded 8.60 cm.

Figure 3 shows the reproductive capability of female rats. Female rats from dietary D (fish meal) had an average of 7 offspring whose mean birth-weight was 3.56 g. The rats in dietary E (groundnut meal) produced 6 offspring whose average birth-weight was 3.14 g. The rats fed with diets B (prawn) had an average of 5 offspring whose mean birth-weight was 4.22 g. The rats from dietary A (groundnut cake) produced an average of 4 offspring whose mean birth-weight was 4.36 g. The rats in this dietary group had the offspring with the highest birth-weight. The rats in dietary C and F produced 3 and 2 offspring whose average birth weights were 3.76 and 3.39 g, respectively. The rats in the control did not produce any offspring before the experiments were terminated. It is speculated that, increased levels of protein supplementation along with other nutrients from the starter mash might have increased the availability and proper balance of nutrients to the pregnant female rats. This might have in turn resulted in higher supply of nutrients to the foetus and has eventually reflected in higher birth-weights. Hossain *et al.* (2003) reported that increase in the levels of supplemental energy improves growth and reproductive performances of female sheep. However, size, weight and health status of female rats are another important factors which may affect the birth-weights of offspring. Doney *et al.* (1982) observed that the provision of proper nutrition before mating is associated with complex interrelation between body weight gain and body conditions of lamb.

Supplementing rats diets with additional proteins have always been producing better results. Evidences have shown that by complimenting livestock's diet with fruits and vegetables can decrease the risk of chronic diseases, such as cardiovascular disease and cancer (Boyer and Liu 2004). Apples contain a wide variety of phytochemicals, many of which have been found to have strong antioxidant activity and anticancer activity. Despite the antioxidant effect on lipoproteins, apple juice intake had a pro-oxidant effect on plasma proteins in both humans and rats (Young *et al*., 1999; Breinholt *et al*., 2003). Some of the apple's protective effect against cardiovascular disease may come from its potential cholesterol-lowering ability. Aprikian *et al.* (2001) found that when cholesterol fed rats were supplemented with lyophilized apples, there was a significant drop in plasma cholesterol and liver cholesterols and an increase in High-Density Lipoproteins (HDL). In obese Zucker rats, apple consumption lowered cholesterol and low-density lipoproteins (Aprikian *et al*., 2001; Leontowicz *et al*., 2002), however in lean rats, apple consumption did not change cholesterol levels (Aprikian *et al*., 2002). This study has shown that by supplementing rats diets with additional proteins the growth, the reproductive capacity and the offspring birth-weights of the rats are greatly enhanced.

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