ISSN 0853-067X

Buletin Penelitian Universitas Djuanda

VOLUME 8, NOMOR 2, AGUSTUS 2004

Lembaga Penelitian — Unida

FAILURE TO SHOW CHANGES OF BODY COMPOSITION IN RATS FED DIETS WITH DIFFERENT LEVELS OF FAT AND PROTEIN

TIDAK ADA PERUBAHAN KOMPOSISI TUBUH PADA TIKUS YANG DIBERI PAKAN DENGAN KANDUNGAN LEMAK DAN PROTEIN BERBEDA

Burhanudin Malik

Jurusan Pertenakan Fakultas Pertanian UNIDA

ABSTRAK

Tiga puluh empat ekor tikus berumur 3 minggu diberi perlakuan ransum dengan kandungan protein dan lemak yang berbeda dan perubahan komposisi tubuhnya diamati. Hasil penelitian tidak menunjukkan bahwa imbangan P/E dalam ransum mempengaruhi efisiensi pertumbuhan dan perubahan komposisi tubuh.

Keywords: P E ratio, body composition

INTRODUCTION

The effect of feed supply on body composition has been well recognized. Many studies have been conducted in this particular subject. Schemmel *et al.* (1973) concluded that the nature of the diet fed to rats after weaning affected their body fat contents. McCargar *et al.* (1989) found that alterations in non-protein energy sources led to metabolic changes. Since fat, compared to protein and carbohydrate, has a greater caloric density, altering the percentage of fat in a diet changes the ration of nutrients to energy. An increase in the percentage of one nutrient, e.g. fat, necessitates a decrease in one or more of the other nutrients, e.g. carbohydrate and/or protein. For instance, rats fed low or inadequate protein level tend to eat more in order to obtain sufficient protein (Leveille and Cloutier, 1987).

This study was conducted to reinforce our understanding on the well- accepted concept that protein/energy (P/E) ratio of the diet has a particular effect on efficiency of growth and changes in body composition. To obtain this aim, a rat feeding trial was carried out in 3 weeks at Johnstone Memorial Laboratory (JML) of Lincoln University Canterbury New Zealand.

MATERIALS AND METHODS

Thirty 3 weeks aged male rats weighing 61-173 g were stratified and randomized into five treatment groups (n=6), so that group means for initial body weight were equal. One group of rats was slaughtered after 24 h starvation on day 1 and subsequently fasted live weights (LW) were obtained. A regression equation ($Y = -0.142 + 0.902$) was derived to estimate the starved LW of the four remaining groups of rats on the first day of the trial. These rats were

Table 1. Composition of diets and dry matter intake (DMI) (/rat/20d)

Ingredients/nutrients/DMI	Diets			
	C	HF	HP	HFHP
Commercial rat diet[1] (g/kg)	1000	920	867	787
Beef tallow (g/kg)	0	80	0	80
Albumin (g/kg)	0	0	133	133
Dry matter (%)	90.37	89.71	89.55	89.93
Organic matter[2] (%)	91.65	92.31	92.21	92.86
Crude protein[2] (%)	20.89	20.72	30.65	27.97
Fat[2] (%)	4.96	13.39	4.27	12.45
Energy (MJ GE)[2]	19.26	21.13	19.82	21.48
DMI (g)	386.84	361.44	336.76	310.65

[1] contains barley, wheat, broll, lucerne, molasses, blood meal, meat meal, milk powder, full fat soya meal, linseed, salt, vitamins, and minerals.

[2] corrected for dry matter

fed one of four diets with different protein and fat contents. Diet in group 1 was a control diet with low fat and low protein (C), diet 2 was high in fat (HF), diet 3 high in protein (HP), and diet 4 high in fat and protein (HFHP). The composition of each diet is given in Table 1.

Rats were fed and had access to water daily *ad libitum*. Feed was offered as paste. Feed refusals were collected after 24 h, stored at 5°C and pooled over a week for each group. Feed samples and feed refusals were sampled weekly and stored at -20°C for pending chemical analysis. Individual body weight was recorded weekly. Food intakes of rats in each group were noted. After 20 days of feeding the rats were starved for 24 h and slaughtered on day 21.

Rat slaughtering was done by euthanasia using carbon dioxide. The killed rats were weighed and stored at -20°C after which each of the rats was minced and stored at -20°C for pending chemical analysis. Feed samples and minced rat samples were analyzed to estimate water, protein (N x 6.25), fat (ether extract), and ash contents.

The effects of treatments on feed intake, live weight gain, and changes in body composition were assessed. Feed efficiency was determined as the amount of feed consumed (g) to give a gram of body weight change. The retention of water, protein, fat, ash, and energy was calculated from their final contents minus their initial contents in rat bodies. Gross energetic efficiency was calculated as the body energy gain per unit GE intake. A statistical analysis using General Linier Model (GLM) of Minitab program was carried out to assess the effects of treatments on each parameter.

RESULTS

Dry matter intake (DMI) for the groups of rats during the 20-d experimental period was shown in Table 1. Rats in control diet showed the highest DMI. Conversely, low DMI was shown by rats fed diet high in both protein and fat. Live weight gain (LWG) and changes of nutrients' body composition of rats as the effects of four diets are shown in Table 2. There were no significant effects of treatments on almost all parameters measured. Neither

Table 2. Effects of diets on live weight gain (LWG) and nutrient balances (mean values ± SEM)

Parameter	Protein	Fat: Low	Fat: High	
LWG (g)	Low	133.0 ± 5.20	132.6 ± 5.20	132.8 ± 3.68
	High	126.1 ± 5.20	131.8 ± 5.20	129.0 ± 3.68
		129.5 ± 3.68	132.2 ± 3.68	
Water (g)	Low	88.28 ± 4.10	87.73 ± 4.10	88.01 ± 2.90
	High	85.85 ± 4.10	86.65 ± 4.10	86.25 ± 2.90
		87.07 ± 2.90	87.19 ± 2.90	
Ash (g)	Low	4.93 ± 0.49	4.77 ± 0.49	4.85 ± 0.35
	High	4.93 ± 0.49	5.02 ± 0.49	4.97 ± 0.35
		4.93 ± 0.35	4.89 ± 0.35	
Protein (g)	Low	27.77 ± 1.43	26.77 ± 1.43	27.27 ± 1.01
	High	26.23 ± 1.43	28.87 ± 1.43	27.55 ± 1.01
		27.00 ± 1.01	27.82 ± 1.01	
Fat (g)	Low	11.25 ± 1.77	12.98 ± 1.77	12.12*± 1.25
	High	8.12 ± 1.77	10.47 ± 1.77	9.29*± 1.25
		9.68 ± 1.25	11.72 ± 1.25	
Energy (kJ)	Low	1123.0 ± 82.91	1166.7 ± 82.91	1144.8 ± 58.63
	High	962.2 ± 82.91	1119.2 ± 82.91	1040.7 ± 58.63
		1042.6 ± 58.63	1142.9 ± 58.63	

* : significantly different at $P<0.05$

LWG nor water, ash, protein, and energy retained in the body was affected by different type of diets. The only significant difference was shown by the amount of fat retained. Rats given low protein diet retained a significantly ($P<0.05$) higher body fat than those given high protein diet (12.12 g *v.* 9.29 g, SEM = 1.25). However, some interesting tendencies were found. Diets with high fat-high protein and low fat-low protein compositions tended to result in higher protein balances (28.87 g and 27.77 g, SEM=1.43, respectively) compared to those with high fat-low protein and low fat-high protein compositions (26.77 g and 26.23 g, SEM=1.43, respectively). Of the energy balance, it tended to be higher in rats fed low protein diet than those fed high protein diet (1144.8 kJ *v.* 1040.7 kJ, SEM=58.63).

DISCUSSION

It is generally believed that rats will modify their feed consumption to their energy requirements with a proportionate increase in consumption in relation to total nutrient dilution (Kleiber, 1975 as cited in McCargar *et al.*, 1989). In other words, rats will reduce their intake when they are fed an energy-dense feed relative to a more diluted feed. The result of the present trial was in accordance with this notion. Compared to those in control diet, rats in high fat diets (HF and HFHP) showed lower DMI, i.e. 386 g/rat/20d (C) *v.* 361 g/rat/20d (HF) and 310 g/rat/20d (HFHP).

Different diets had no significant effects on the water content of the rat bodies. This was in agreement with the results of Wood and Reid (1975) who fed the rats with low and high fat diets. Body ash contents of rats were not affected by diets either. This suggested, as Schemmel *et al.* (1973) pointed out, that bone development is more resistant to change by dietary manipulation.

Shimomura *et al.* (1990) found that beef tallow utilization in a diet resulted in a higher fat accumulation in rats than did the safflower. This result was confirmed by that of Takeuchi *et al.* (1995) who by using lard and other vegetable oil concluded that dietary fatty acid composition could lead to different fat accumulation in the body. They found that fats rich in saturated fatty acids compared to those rich in monounsaturated and polyunsaturated fatty acid decreased diet-induced thermogenesis resulting in promotion of body fat accumulation. The source of fat in the high fat diets in the present study was beef tallow, which is rich in saturated fatty acids. However, there was no significant effect of high fat diet on body fat balance. Even though this present study did not assess the effect of fatty acids, it can be said that the result of the present study to a certain extent was in line with the findings of Awad *et al.* (1990) that failed to show any effect of dietary fatty acid composition on body weight, feed intake, and body composition. The effect of dietary fatty acid composition on body fat accretion seems to be dependent on the experimental condition such as the age of the animals, the overall level of fat in the diet, and the length of the feeding period (Hill *et al.*, 1983 as cited in Takeuchi *et al.*, 1995). Regarding the latter, the feeding period conducted by Shimomura *et al.* (1990) was 4 months while in the present study, it was carried out for only 3 weeks.

High fat diet tended to result in higher protein balance. An increase of fatty acid in blood can lead to an increase in the rate of fatty acid oxidation in the muscle. Subsequently, the glucose utilization and oxidation are reduced (Newsholme and Leech, 1986 as cited in McCargar *et al.*, 1989). In such a condition, therefore, it can be inferred that amino acid oxidation would also be reduced (McCargar *et al.*, 1989). Thus, when feeding a high fat diet, amino acid oxidation and protein degradation may decrease, less fatty acids would be stored as triglycerides and a higher protein stored in the muscle can be expected. Even though neither the high-fat nor the low-fat diet in the present study gave a different effect on body fat composition, there was a significant effect of different level of protein on body fat composition. Low-protein diet gave a significantly ($P<0.05$) higher body fat gain (12.12 g) than did the high-protein diet (9.29 g). An excess of energy that was not immediately used in low-protein diet might explain this phenomenon. However, this was not proven in the present study as there was no different energy gain in rats fed low-protein and high-protein diets. If the energy yielded from dietary fat catabolism is not immediately used, it can be converted into triglycerides and deposited into adipose tissue (Flatt, 1978 as cited in Leveille and Croutier, 1987). Instead of on dietary carbohydrate, rats fed a high-fed diet would rely on dietary fats and incorporate them into fat stores, which may result in a more energetically efficient process (Schiemann, 1969 as cited in Wood and Reid, 1975). In the present study, however, the gross energetic efficiency in diets high in fat was not proven to be different.

Feeding a high-protein diet was found to raise body weight and body fat composition of rats (Donald *et al.*, 1981 as cited in Leveille and Cloutier, 1987). They found that the use of 5 and 25% of protein in diets resulted in changes of body weight and body fat composition from 397 to 487 g and 16 to 24%, respectively. Results of the present study were not in agreement with those of Donald *et al.* (1981). Rats fed diet with lower protein content gained a higher amount of fat body composition than those fed diet with higher protein content (12.12 v. 9.29 g, $P<0.05$) whereas rates of live weight gain of the rats were not different. These different results were probably due to the difference in caloric content of the diets. Diets used by Donald *et al.* (1981) were equal in caloric content while

In the present study the GE intakes of rats in high-protein diets were lower than those in other diets.

CONCLUSION

The importance of P/E ratio in change of body composition was not exclusively confirmed in this study. However, there was a trend that either low protein-low fat diet or high protein-high fat diet gave a higher protein gain than did the high protein-low fat diet or low protein-high fat diet. This indicated that if a high intake of protein is not accompanied by an adequate amount of energy, as in the high protein-low fat diet, the efficiency of nitrogen use will reduce. Similarly, an excessive energy compared to the amount of protein intake, as in the low protein-high fat diet, could lead to deposit of triglycerides into adipose tissue as described earlier. However, the latter was not either confirmed in the present study.

REFERENCES

Awad, A.B.; Bernardis, L.L.; Fink, C.S. 1990. Failure to demonstrate an effect of dietary fatty acid com-position on body weight, body composition, and parameters of lipid metabolism in mature rats. *J. Nutr.* 120:1277-1282.

Laveille, G.A. and Cloutier, P.F. 1987. Isocaloric diets: effects of dietary changes. *Am. J. Clin. Nutr.* 45: 158-163.

McCargar, L.J.; Baracos, V.E.; Candinin, M.T. 1989. Influence of dietary carbohydrate-to-fat ratio on whole body nitrogen retention in adult rats. *J. Nutr.* 119:1240-1245.

Schemmel, R.; Mickelsen, O.; Fisher, L. 1973. Body composition and fat depot weights of rats as influ-enced by ration fed dams during lactation and that fed rats after weaning. *J. Nutr.* 103: 477-487.

Shimomura, Y.; Tamura, T.; Suzuki, M. 1990. Less body fat accumulat-ion in rats fed a safflower oil diet than in rats fed a beef tallow diet. *J. Nutr.* 120:1291-1296.

Takeuchi, H.; Matsuo, T.; Tokuyama, K.; Shimomura, Y.; Suzuki, M. 1995. Diet-induced thermogene-sis is lower in rats fed a lard diet than in those fed a high oleic acid safflower oil diet, a safflower diet, or a linseed oil dirt. *J. Nutr.* 125:920-925.

Wood, J.D. and Reid, J.T. 1975. The influence of dietary fat on fat metabolism and body fat deposition in meal-feeding and nibbling rats. *Brit. J. Nutr.* 34: 15-24.