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Some Effects of Alternate Feeding of High-protein and Low-protein Diets to Growing Rats

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=國文抄錄=

高蛋白質과 低蛋白質 飼料의 交代給與가 쥐의 成長에 미치는 影響

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要 約

離乳한 40마리의 Albino쥐에게 高蛋白과 低蛋白 飼料를 間隔을 달리하여 交代로 給與하였을때 成長率, 飼料效率, 蛋白質 效率, 肝臟과 內臟의 무게, 蛋白質 消化率, 窒素均衡 等을 調査하였는데 그 結果를 要約하면 다음과 같다.

1. 1日 間隔으로 高蛋白質과 低蛋白質飼料를 交代로 給與한 B區는 中蛋白質飼料를 每日 給與한 A區와 成長率, 飼料要求率에 아무런 差異가 없었다. 그러나 2日 또는 3日間 低蛋白質 飼料를 給與한 다음 하루동안 高蛋白質 飼料를 給與하여도 中蛋白質 飼料를 每日 給與한 區와 同一한 成長率을 가져오지 못하였다.
2. 各區間 蛋白質 效率에는 아무런 有意差가 없었다.
3. 肝重은 體重에 比例하였으나 腸重 및 腸長은 各區간 差異가 없었다.
4. 各區間 蛋白質의 消化率에는 有意差가 없었으나 尿中 窒素 排泄은 B, C, D區가 모두 A區에 比해 有意的으로 컸으며 窒素 攝取量에 對한 體內 蓄積率도 窒素 攝取量이 많은 區가 떨어졌다.

I. INTRODUCTION

The protein requirement of man and of different animals is usually defined as the quantity which must be consumed during a 24-hour period in order to promote growth or to maintain good health. However, actually the day to day protein intake may vary considerably.

For instance, in the developing countries people usually consume small quantities of protein of vegetable origin and seldomly eat the meals provided with large amount of good quality protein. Volkmann (1947) sugested that dietary protein can be more effeciently utilized during the days immediately following the periods of restricted protein intake. However, Geiger(1955) reported differently.

Here et. al. (1948) reported that weaning rats grew as well and utilized dietary protein with the same efficiency for growth, whether it was supplied at a constant level in the diet or whether supplied alternately daily about the same value as a mean. In their experiments, however, protein was with held for only one day and this period may have been too short to influence protein utilization.

The purpose of this experiment was to find the some effects between daily adequate protein feeding and alternate feeding of high protein

and low protein in different intervals to the growing male rats.

Ⅱ. MATERIAL AND METHODS

Forty weaning albino rats at an averaeg body weight of 70 gm. were assigned to the 4 groups of 10 rats. The rats were placed in individual wire cages. The feed was offered ad libitum in the porcelain feed bowls and the water was supplied from glass drinking bottles attached to the front of each cage.

The composition of diet is described in Table 1.

The rats of group A were offered complete diet daily: group B received casein free diet and casein diet B alternately; group C received casein free diet for two days and casein diet C on the 3rd day; group D received casein free diet for the consecutive three days and casein diet D on the 4th day. The casein free diet contain about 7.59% of protein from rice.

Each rat of each group was weighed every 6 days and individual feed consumption records were kept for the entire period of the experiment at 2:00~4:00 p.m. every day.

At the end of the experiment of 24 days, 4 rats from each group were euthanized with ether and killed. The liver weight, intestinal length and weight were measured. The 4 rats from each group were transferred to the metabolic cages which allowed complete freedom of movement of the rats and separate collection or urine and faces, The feces remained on the fine metal screen while the urine was allowed to pass into the collection bottle located under the each cage.

About 2 ml of strong hydrochloric acid was added to the collection bottle when the collection was started. The nitrogen contents of urine and feces was determined by means of the micro-kjeldahl method as outlined by the A.O.A.C. (1970).

At the termination of the metabolic experiment, the rats were fasted for 18 hours to obtain

Table 1. Diet composition (%)

Group / Diet / Component	A Casein diet A	B Casein diet B	C Casein diet C	D Casein diet D	Casein free diet F
Rice	69.60	58.00	49.71	43.50	87.00
Corn oil	5.00	4.17	3.57	3.13	5.25
Casein	20.00	33.33	42.86	50.00	—
Vitamin mixture[1]	2.40	2.00	2.15	1.50	3.00
Mineral mixture[2]	3.00	2.50	2.15	1.87	3.75
Total	100.00	100.00	100.00	100.00	100.00
Chemical composition:					
Protein	24.43	35.65	43.68	49.69	7.59
G.E.(kcal/kg)	3,781	3,867	3,929	3,976	3,652

1. Vit. mixture (mg/100g of mixture). Vit. A 20,000 IU., Vit. D 5,000 IU., Vit. E 200, Vit. K(Menadione $NaHSO_3$) 0.3mg, choline chloride 4,000, Niacin 100, Ca-pantothenate 40, Riboflavin 15, Thiamin HCl 6, Pyridoxine HCl 40, Vit. B_{12} 0.03.
2. Min. Supple. (J. Nutr. Vol. 80, No. 3. 1963) g/100g of Mixture; Nacl 2.84, $NaHPO_4$ 1.87, $KHCO_3$ 15.91, $Ca_3(PO_4)_2$ 37.79, $Ca(H_2PO_4)_2 \cdot H_2O$ 37.79, $MgCO_3$ 2.39, $FeSO_4 \cdot 7H_2O$ 0.43, $CuSO_4 \cdot 5H_2O$ 0.07 $MnSO_4 \cdot H_2O$ 0.53, KIO_3 0.0087, $ZnCO_3$ 0.16, $Na_2S_2O_3$ (anhydrous) 0.00033.

Table 2. Feeding schedule of diets during experimental period

Group \ Day	1	2	3	4	5	6	7	8	9	10	11	12
A	A	A	A	A	A	A	A	A	A	A	A	A
B	F	B	F	B	F	B	F	B	F	B	F	B
C	F	F	C	F	F	C	F	F	C	F	F	C
D	F	F	F	D	F	F	F	D	F	F	F	D

Table 3. Weight gain, feed consumption and protein intake of the rat of each group (per head)

Group	A	B	C	D
Total body weight gain (gm)	73.1^{b*}	73.0^{b}	49.0^{a}	45.6^{a}
Total feed intake (gm)	188.5^{bc}	193.6^{ab}	176.6^{ab}	173.2^{a}
Feed effeciency	2.73^{a}	2.56^{a}	3.63^{b}	4.27^{b}
Total protein intake (gm)	46.05^{d}	42.28^{c}	33.25^{b}	28.60^{a}
Protein efficiency ratio	1.58	1.73	1.47	1.59
No. of observation	8	9	7	10

* Alphabet corresponds to significant difference ($p<0.05$)

the shrunk body weight (SBW). Then, the rats were killed by putting them in a closed jar with ether moistened papers. The rats were dissected to remove the digestive tract and the contents of digestive tract were discarded and the empty digestive tract was put back into the abdomen.

Ⅲ. RESULTS AND DISCUSSION.

Effects of alternating feeding diets containing different level of protein on weight gain, feed consumption, feed efficiency and protein intake are shown in table 3, 2 rats in A group, 1 rats in B group and 3 rats in C group died without specific cause during experimental period.

The rats in A and B group grew more rapidly than those in C and D group. ($p<0.01$) during experimental period. This shows that the rats fed high protein and low protein diet alternately in every other day grew equally with the rats fed control diet dialy but the rats fed high protein diet once every three days or every four days could not grow equally with the control rats.

Geiger et al(1956) reported the same results with young growing rats and adult rats, in which the control group was given ad libitum the 12% protein diet and B group was received the 4% protein diet during three days of each 5-day period and 18% casein diet on the 4 th and 5th days of this period. They reported the animals of B group did not reach the weight of the control group.

An analysis of the feed intake indicates that the rats of A,B,C, and D groups consumed 188.5 gm, 193.6 gm, 176.6 gm, 173.2 gm, respectively, which shows a highly significant difference among groups ($p<0.01$).

The reason of decreased feed consumption in C and D groups is that the rats could not eat much of the casein diet C and D because they contained as much as 43.6% and 49.69% protein, respectively.

Therefore, the feed efficiency of C and D group increased significantly over that of A and B groups ($p<0.01$). The total protein intake

Table 4. Liver weight, intestine weight and length of the rat in each group

Group	A	B	C	D
Livcr wt. (g)	7.54[c]*	6.80[c]	3.98[a]	5.22[b]
Liver wt./body wt (%)	5.40	4.51	4.38	4.53
Intestine wt. (g)	6.06	5.97	4.66	5.27
Intestine/body wt. (%)	4.28	3.96	3.95	4.57
Intestine length (cm)	114.8	118.5	111.3	108.5
Intestine length/body wt. (%)	81.87[a]	78.65[a]	95.36[b]	94.09[b]
No. of observation	4	4	4	4

* Alphabet corresponds to significant difference ($p<0.05$)

Table 5. Digestibility of protein of the rat in each group

Group	A	B	C	D
Total protein intake per head(gm)	19.91[a]*	17.15[b]	15.43[c]	15.90[c]
Feces protein per hed (gm)	1.69[a]	1.18[b]	1.22[b]	1.18[b]
Digestible protein (gm)	18.22[a]	15.97[b]	14.21[c]	14.72[c]
Protein digestibility (%)	91.57	93.12	92.11	92.58

* Alphabet corresponds to significant difference ($p<0.05$)

Table 6. Nitrogen balance of the rat in each group

Group	A	B	C	D
Total nitrogen intake (gm)	3.19[c]	2.74[b]	2.47[a]	2.54[a]
Feces nitrogen (gm)	0.27	0.19	0.20	0.19
Urine nitrogen (gm)	1.19[c]	0.85[b]	0.78[b]	0.55[a]
Nitrogen balance(gm)	+1.73	+1.70	+1.49	+1.80
Retained N/N intake (%)	54.23[c]	62.04[b]	60.32[b]	70.87[a]

during the experimental period shows significant differences among treatments ($p<0.01$), but the protein efficiency ratio was the same in each group. This means the protein utilization efficiency was not increased by intermittent feeding of protein diet, which is in agreement with Geiger et al. (1955).

The liver weight shows significant differences between each treatment ($p<0.05$). This means that the liver weight was in proportions to total weight gain. The intestine weight and intestine length appears not to be affected by the alternate feeding of diets containing different level of protein.

The protein digestibilities of each group shows no significant differences, however, nitrogen losses in group A was greater than that in group B,C, and D ($p<0.05$).

The high digestibilities appears to be partly due to coprophage which could not be prevented completely during digestion trial.

Table 6 shows that nitrogen retention ratio as a percentage of nitrogen intake increased in intermittent casein feeding groups ($p<0.05$).

This result means the gain of nitrogen as a food nitrogen decreased with increased dietary

protein, (Hartsook, et al. 1967, 1973) because the urinary nitrogen loss of control group was significantly higher than that of intermittent casein feeding groups ($p<0.05$).

Ⅳ. SUMMARY

Forty weaning albino rats were used to find the effects of alternate feeding of high protein diet with different intervals on growth, feed efficiency, protein efficiency ratio, weight of some internal organ, protein digestibility and nitrogen balance. Results obtained are summarized as follows:

1. The growth rate and feed efficiency of group B fed high protein and low protein alternately in every other day was equal to that of A group fed medium protein diet daily. However, the rats fed high protein diet once every three days or every four days could not result in same growth that obtained by group A.

2. The protein efficiency ratio of each group was the same without significant difference.

3. The liver weight appeared to be in proportion to final body weight, but intestine weight and length appeared not to be affected by treatments.

4. The protein digestibility in each group was insignificant. However, urinary nitrogen loss of intermittent high protein feeding group was lower than that of control group and the nitrogen retention ratio decreased with increased nitrogen intake.

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