

Effects of calcium, protein and fat on dietary selection, growth rate and bone development of the choice fed broiler chick.

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#### INTRODUCTION

A complete diet based on the average nutrient requirement of a whole flock is commonly fed to poultry which preclude self selection of nutrients. It is formulated and balanced to meet the average nutrient requirements of the birds, for the period during which the food is used.

A balanced diet is defined as a diet on which birds can satisfy their nutritional requirements as efficiently as possible. The nutrients have therefore to be provided in the correct proportions for the birds.

Nutrient requirements are influenced by strain, age, sex, environmental temperatures and rate of growth/egg output. For instance, within and between breeds, individual birds grow at different rates and fast growing birds require more protein per unit of energy in their diets than slow growing birds. With complete diets all

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birds have to receive the same proportions of protein and energy which are based on the average requirements of the flock.

Under these conditions rapidly growing birds will have a shortage of protein or amino acids, and the slow growing birds will have excess.

Environmental temperature is another factor which influences the optimum balance of energy and protein. At low environment temperature birds have a higher requirement for energy, and feed intake increases accordingly, consequently protein intake is also increased. Ideally the level of dietary protein should be related to environmental temperature, so that protein intake is constant at any temperatures. This, however, would not be practicable. The problem then is how to feed poultry efficiently when there is such variability in the optimum nutrient concentration required for growth and other forms of production.

It has been suggested (Michie, 1977) that the problem would be solved by giving birds a choice of two types of food, one higher in protein, and the other higher in energy, and allowing them to balance their intake according to their requirements. From the economic point of view, free choice feeding offers certain benefits to producers. Karunajeewa (1978) reported that feed processing costs were reduced when a whole cereal was used as a source of energy and the birds' own grinding mechanism was utilized. There was no reduction in egg output with

this system of feeding. It has been shown that free choice feeding of grain and a higher protein feed may permit a more efficient feeding of nutrients in poultry (Emmans, 1975).

This system of feeding was popular many years ago but was abandoned in favour of complete feeds, probably because it was easier to automate the delivery of one feed to birds.

From the foregoing discussion, it can be generally concluded that free choice feeding has several advantages. Emmans (1979) has gone as far as concluding that this particular feeding system is the only way of improving on the present methods of feeding (complete diet given ad libitum).

However, it appears that the full potential of choice feeding cannot be exploited until it is fully understood. There are apparently many factors which influence diet selection by poultry, some of which are largely unknown. It was for these reasons that the present study was undertaken.

The purpose of this study was to investigate the effect of dietary calcium and protein levels and fat sources on diet selection, growth rate and bone development of the female broiler chicken.

#### Material and Methods:

Six hundred day old Ross 1 female broiler chickens were reared as one group, on wood shaving litter in a

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windowless, controlled environment house.

Two brooder units were used as a source of heat. Each unit had two electrically heated tiers. The initial brooding temperature was 33°C. reduced by 3°C weekly until it remained constant at 17°C.

The chickens were fed on broiler starter crumbs (208 g crude protein and 12.0 MJ ME/kg). Initially 10 small feeders (starter trays) and 12 drinkers were used; at 7 days old an extra automatic drinker was added and feeders were changed to a bigger size.

The photoperiod was adjusted to 23 hours and 30 minutes each day.

At 21 days of age 540 chickens were selected, wing banded, transferred to the second controlled environment house, and distributed between 36 rearing cages (15 birds in each cage) according to a randomized plan.

The house had two stacks of three tier cages, of which each tier was divided into six sections, to give twelve groups at each tier level in the house.

A randomized block design was used, and each of twelve Treatment (according to the twelve diets) allocated randomly to the groups in each tier level, which thus formed the block. Each replicate contained 15 chickens.

Three levels of calcium (7.5, 15 and 22.5 g/kg), two levels of protein (205 and 300 g/kg), two sources of fat (saturated (S) and unsaturated (U)), and two levels of fat (0 and 50 g/kg) were used to formulate twelve diets. The levels of other nutrients were adequate (Table 1).

The twelve diets and treatments were as follows:

<u>Diet (and treatment) no.</u>	<u>Fat</u> (g/kg)	<u>Protein</u> (g/kg)	<u>Calcium</u> (g/kg)
1	0	205	7.5
2	0	205	15
3	0	205	22.5
4	50u(1)	205	7.5
5	50u	205	15
6	50u	205	22.5
7	50S(2)	205	7.5
8	50S	205	15
9	50S	205	22.5
10	50u	300	7.5
11	50u	300	15
12	50u	300	22.5

(1) unsaturated, (2) saturated

The drinkers were automatic. Balancer was supplied at the central food trough, and whole wheat at the side food troughs in each cage. The birds had free access to both food troughs and were allowed to select their own diet in a two-choice situation between whole wheat and balancer.

Both food and water were supplied ad libitum. Regulated quantities of flint grit were supplied initially on food starter trays and then from 21 days of age in each food trough.

The birds were weighed at 3,4,5,6,7 and 8 weeks of

age. Food consumption and mortality were recorded and consumption was adjusted for mortality.

At 8 weeks of age 3 chickens were taken at random from each cage and slaughtered. The muscular layers covering the tibia were removed, as closely as possible, with a scalpel, then x-rayed; their length and midshaft diameter were measured directly from x-ray film. Connective and soft muscular tissues were finally removed by boiling the bone in a 1% solution of sodium hydroxide, for about ten minutes, then the tibia was thoroughly washed, dried in an oven at 100°C overnight. The cooled tibia was weighed and ashed at about 600°C. The weight of the ash was expressed as a percentage of the weight of the dried tibia.

#### Statistical analysis

An analysis of variance was carried out for the body weight, food intake, growth rate, food conversion ratio, whole balancer intake, whole wheat intake, percentage whole wheat intake of total food intake, protein intake, calcium intake, length, width and ash percentage of the bones, at 8 weeks old. Comparisons among treatments were tested using L.S.D. test. Either one factor or more were included in the analysis of variance table appropriate.

Table 1 Composition of experimental foods

Ingredients (kg/t)	Treatment											
	1	2	3	4	5	6	7	8	9	10	11	12
Ground wheat	550	557.1	571.4	472.8	482.85	482.85	498.28	508.0	508.0	274.0	283.57	283.57
Ground maize	164.2	171.4	164.2	71.4	71.42	71.42	71.42	71.42	71.42	71.42	71.42	71.42
White fish meal	78.5	142.8	171.4	71.42	114.28	114.28	71.42	114.28	114.28	71.42	114.28	114.28
Soya bean meal	188.5	90.0	45.71	234.42	168.57	168.57	228.57	162.85	162.85	495.14	429.42	429.42
Corn oil	-	-	-	50	50	50	-	-	-	50	50	50
Tallow	-	-	-	-	-	-	50	50	50	-	-	-
Vitamin/mineral supp (1)	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14	7.14
Lysine	0.071	-	-	-	-	-	-	-	-	-	-	-
D L-methionine	0.51	0.14	-	0.551	0.342	0.28	0.528	0.314	0.314	1.42	1.214	1.214
Monocalcium phosphate	10.8	2.85	-	12.14	6.74	6.74	12.07	6.71	6.71	9.71	4.28	4.28
Limestone	-	13.3	31.0	0.371	16.57	38.0	0.414	16.61	38.0	0.0714	16.28	37.72
Salt	0.45	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	-	-	-
Fine sand	-	13.85	7.67	78.33	80.66	59.30	58.73	61.25	39.86	19.67	22.39	0.95

Analysis by calculation

ME (MJ/kg)	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5	11.5
Crude protein (g/kg)	205.4	205.4	205.4	205.4	205.4	205.4	205.4	205.4	205.4	300.0	300.0	300.0
Calcium (g/kg)	7.5	15.0	22.5	7.5	15.0	22.5	7.5	15.0	22.5	7.5	15.0	22.5
Available P (g/kg)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7

Chemical analysis (g/kg)

Crude protein	206.5	199.9	195.8	207.1	209.8	201.4	211.4	202.6	204.4	290.1	270.5	287.2
Fat	27.6	35.1	31.4	68.7	63.7	63.5	61.3	68.4	69.3	71.7	64.3	70.5
Calcium	8.9	16.1	24.9	8.1	12.5	16.4	10.2	13.5	25.9	8.4	13.6	29.5
Phosphorus	9.1	9.9	9.2	9.4	8.6	8.6	9.4	9.6	9.7	9.6	9.6	10.5

(1) Concentrations (per kg vitamin-mineral supplement):

Vit A 10 miu	
Vit D 2 miu	
Vit E 5 g	
Vit B <sub>2</sub> 4.5 g	
Vit B <sub>12</sub> 8 mg	Folic acid 0.25 g
Vit K 2 g	Manganese 80 g, Zinc 50 g, Copper 10 g,
Nicotinic acid 24 g	Cobalt 1 g, Iodine 1.5 g,
Pantothenic acid 9 g	Iron 30 g, Selenium 0.1 g,
Choline chloride 320 g	Methionine 600 g
Thiamine 0.5 g	Antioxidant + Pyzone (nitrovin) 10 g
Pyrodoxine (Vit B <sub>6</sub> ) 0.5 g	Zinc Bacteracin 10 g

## RESULTS

F values are given in Tables 2 and 3. Comparisons between treatment means are given in Tables 4 and 5 for the following variables: final body weight (FBW) at 56 d of age, growth rate (GR), total food intake (TFI), food conversion ratio (FCR), balancer intake (BI), protein intake (PrI), calcium intake (CaI), whole wheat Intake (WI) and percentage of wheat in total food Intake (pWI) for the period 21-56 d. Bone ash percentage (B. Ash), bone length (B. length) and bone width (B. width) at the end of the period are also included. The analyses



for Tables 2 and 4 involve the calcium and fat treatments, Tables 3 and 5 calcium and protein, and Table 6 presents a comparison of all treatments.

Figures 1,2 and 3 show the body weight of the chickens weekly from 21 to 56 days of age for the different treatment according to the levels of protein (Fig. 1), fat (Fig. 2) and calcium (Fig. 3). Figures 4,5 and 6 show whole wheat intake as a percentage of total food intake on a weekly basis according to the levels of dietary protein (Fig. 4), fat (Fig. 5) and calcium(Fig.6).

#### Initial body weight

There were no significant differences in body weight between chickens in the different treatments when the experiment started at 21 d of age (Table 6).

#### Final body weight

It is shown in Tables 2 and 3 that there were no significant differences in final body weight between treatments at 56 d of age except treatments which received saturated fat in their balancers (Table 4). Their final body weight was significantly higher than treatments with no added fat in their balancers.

#### Growth rate

All treatments appear to have an identical effect on growth rate, except those which received saturated fat in their balancers (Tables 4 and 5). Their growth rate was significantly higher than treatments with no

added fat in their balancers.

#### Total food intake

The level of protein in the balancer significantly affected total food intake (Table 3). The birds in low protein balancer (LPB) had a significantly higher intake than those on the high protein balancers (HPB) (Table 5). There were no significant differences between treatments which involved balancers with different levels of calcium and different sources of fat (Tables 4 and 5).

#### Food conversion ratio

Different balancers significantly affected FCR. Treatments with high levels of calcium under different sources of fat (DF) had higher FCR than medium and low levels of calcium (Table 4). No significant differences were observed between treatments with different levels of calcium under different levels of protein (DP) (Table 5). Treatments with HPB gave more efficient feed utilisation than LPB (Table 5). There were no significant differences between saturated and unsaturated fats and both were significantly better than treatments which received balancers without fat (Table 4).

#### Total balancer intake

Tables 2 and 3 show that different levels of calcium in both conditions (different levels of protein and different sources of fat) significantly affected TBI. No significant differences were found between treatments

with low and medium levels of calcium (under different sources of fat) which were significantly higher than high calcium treatments (Table 4). Also, no significant differences were observed between high and medium calcium treatments (under different levels of protein), which were significantly lower than low calcium treatments (Table 5).

Although TBI was higher in low protein than high protein treatments, there were no significant differences between them (Table 5).

Treatments with saturated fat had a significantly higher TBI than treatments with unsaturated fat. However, there were no significant differences between treatments with no fat and treatments with saturated or unsaturated fat (Table 4).

#### Total wheat intake

As is shown in Table 4, no significant differences were found between treatments with low and medium levels of calcium (under different sources of fat) which were significantly lower than high calcium treatments. Also no significant differences were observed between medium and high calcium treatments (under different levels of protein) which were significantly higher than low calcium treatments (Table 5).

TWI for low protein treatments was significantly higher than for high protein treatments (Table 5).

Treatments with saturated fat gave a significantly lower TWI than treatments with unsaturated fat. However,

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there were no significant differences between treatments with no fat and treatments with saturated or unsaturated fat.

Whole wheat intake as a percentage of total intake

The type of balancers given to the birds significantly affected PWI at  $P \leq 0.001$  (Tables 2 and 3). There were no significant differences between treatments with low and medium calcium (under different sources of fat), which were significantly lower than treatments with a high level of calcium (Table 4). Also no significant differences were observed between treatments with medium and high level calcium (under different levels of protein) which were significantly higher than low calcium treatments (Table 5).

Although PWI was higher with low protein treatments, there were no significant differences between them (Table 5).

PWI for treatments with unsaturated fat was significantly higher than with saturated. There were no significant differences between treatments with no fat, and treatments with saturated or unsaturated fat (Table 4).

Total protein intake

The treatments affected the protein intake (Tables 2 and 3). Under different sources of fat, no significant differences were found between low and medium calcium treatments (Table 4).

Under different levels of protein, no significant

differences were found between medium calcium and high calcium treatments, which were significantly lower than low calcium treatments (Table 5).

TPI for high protein treatments was significantly higher than for low protein treatments (Table 5).

Treatments with saturated fat gave a significantly higher TPI than those with unsaturated fat or no fat. No significant differences were observed between treatments with unsaturated fat and treatments with no sources of fat.

#### Total calcium intake

Type of choice offered significantly affected calcium intake at  $P \leq 0.001$  (Tables 2 and 3).

With either different sources of fat or different levels of protein, high calcium treatments had the highest calcium intake, which was significantly higher than with medium and low calcium treatments. Also in the medium calcium treatments (under both conditions) the calcium intake was significantly higher than the low calcium treatments (Tables 4 and 5).

Different sources of fat and different levels of protein appear to have had identical effects of calcium intake (Tables 4 and 5).

#### Bone ash

Different levels of calcium (under different levels of protein or different sources of fat) appear to have had an identical effect on bone ash. Bone ash with the

TABLE 6 A summary of the results between 21-56 days of age for the different treatments (treatment means)

Treatments	1	2	3	4	5	6	7	8	9	10	11	12	SED	Critical differences	Main effect (3)
Diets	Fat O CP L Ca L	Fat O CP L Ca M	Fat O CP L Ca H	Fat U CP L Ca L	Fat U CP L Ca M	Fat U CP L Ca H	Fat S CP L Ca L	Fat S CP L Ca M	Fat S CP L Ca H	Fat U CP H Ca L	Fat U CP H Ca M	Fat U CP H Ca H			
Initial bodyweight (kg/b)	0.552	0.556	0.555	0.547	0.551	0.564	0.565	0.550	0.56	0.550	0.547	0.546	0.326	21.34	N.S.
Final bodyweight (kg/b)	2.176	2.184	2.134	2.2178	2.223	2.230	2.264	2.225	2.19	2.175	2.178	2.177	0.0427	0.08	N.S.
Growth rate (g/b/d)	46.23	46.51	45.07	46.20	47.75	47.53	48.55	47.85	46.61	46.27	46.59	46.58	1.089	2.25	N.S.
Total food intake (g/b/d)	122.65	123.98	122.29	121.2	124.07	126.68	127.74	122.85	123.82	118.79	117.89	118.36	2.210	4.57	**
Food conversion ratio	2.650	2.66	2.71	2.62	2.59	2.663	2.626	2.566	2.65	2.560	2.52	2.53	0.0299	0.062	***
Balancer intake (g/b/d)	69.22	62.96	55.09	64.89	61.103	55.86	71.55	72.013	60.39	68.26	53.95	53.12	4.247	8.79	***
Whole wheat intake (g/b/d)	53.42	61.02	67.20	56.31	64.86	70.81	56.196	50.336	63.42	50.513	63.933	65.23	4.272	8.84	***
Whole wheat intake (1)	43.55	49.22	54.99	46.45	52.28	55.90	44.00	41.19	51.26	42.58	54.21	55.1	3.336	6.9	***
Protein intake (g/b/d) (2)	19.77	19.27	18.3	19.18	19.29	18.83	20.53	20.07	18.99	25.73	22.83	22.71	0.609	1.26	***
Calcium intake (g/b/d) (2)	0.54	0.96	1.26	0.50	0.94	1.28	0.55	1.1	1.38	0.53	0.83	1.22	0.071	0.148	***
Bone ash (4)	51.70	51.45	51.10	52.14	53.20	51.47	49.10	50.23	51.81	49.38	51.30	50.37	1.21	2.50	N.S.
Bone length (5)	11.02	10.85	11.06	11.36	11.21	11.06	11.00	11.21	11.26	11.35	11.11	11.21	0.195	0.40	N.S.
Bone width (6)	8.09	7.53	7.65	7.84	7.47	7.41	8.01	7.44	7.92	7.84	7.27	7.54	3.8	7.88	N.S.

(1) Percentage of total food intake

(2) Assessed from calculated values

(3) NS (not statistically significant), \* =  $P < 0.05$ , \*\* =  $P < 0.01$ , \*\*\* =  $P < 0.001$

(4) Percentage of dry bone weight, (5) centimeters, (6) millimeters

(5) CP (crude protein), Ca (calcium), O (non supplemented fat), U (unsaturated fat), S (saturated fat), L (low), M (medium), H (high)

low protein treatments was significantly higher than high protein treatments (Table 5). Bone ash for the treatments with unsaturated fat was significantly higher than for the treatments with saturated. However, no significant differences were found between treatments with no fat and treatments with saturated or unsaturated fat (Tables 4 and 5).

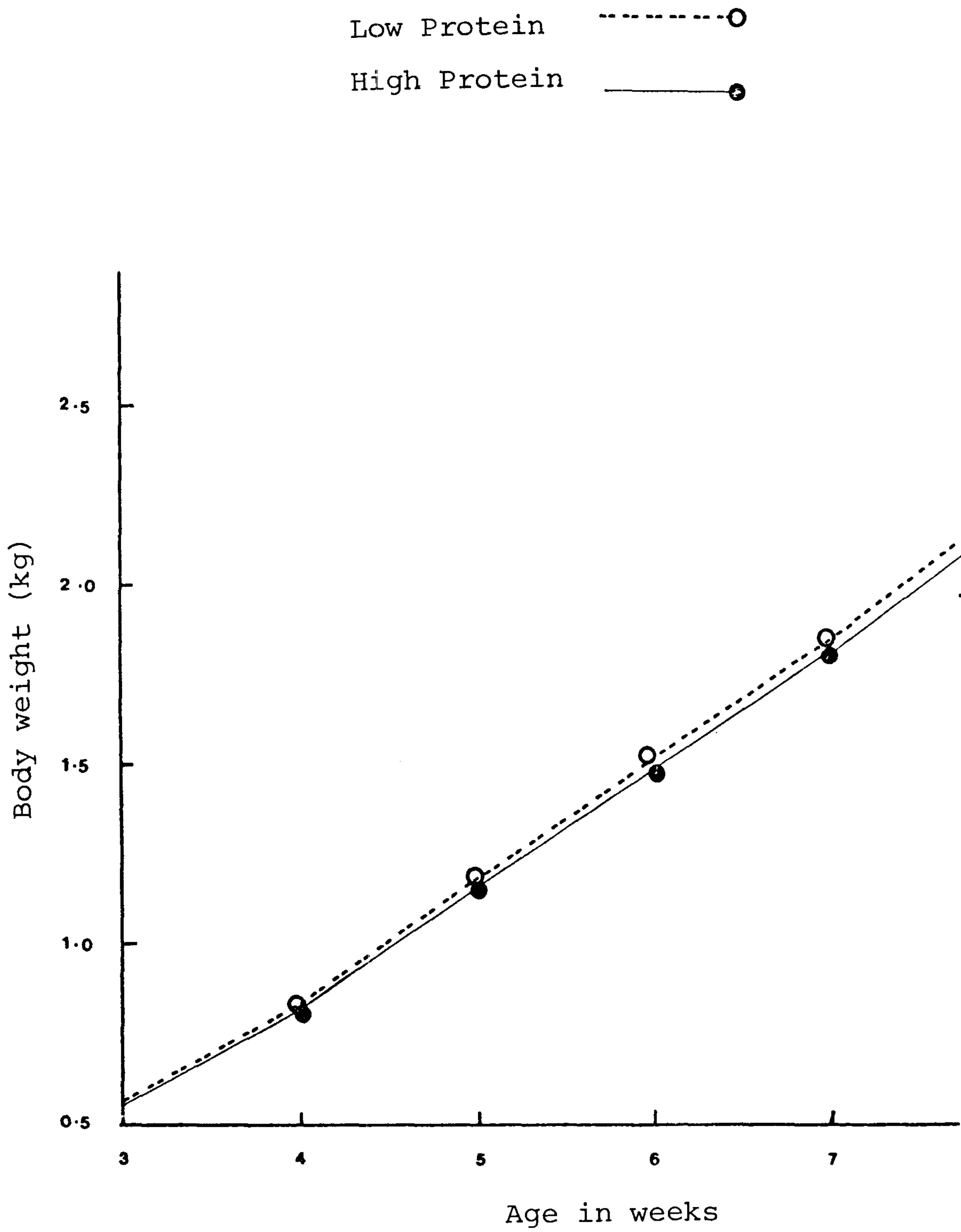
#### Bone length and width

There were no significant differences in length and width of the bones, between treatments (Tables 4 and 5).

### DISCUSSION AND CONCLUSION

Comparing the factors examined calcium level of the balancers had the greatest effect on food preferences. An interesting point on diet selection is that the birds react to change in dietary calcium level by eating a higher proportion of whole wheat as the calcium level increases (Tables 4 and 5). This is consistent with the birds' avoiding to some extent excess calcium intake, a result in agreement with the finding of Wood-Gush et al (1966) That chicks are able to form a specific appetite for calcium. It also supports Emmans (1979), who found that with pullets given a choice between whole barley and a complete diet given a choice between whole barley and a complete diet (three calcium levels x two protein levels), the percentage of total food intake consumed as whole barley increased as the level of calcium of the complete diet

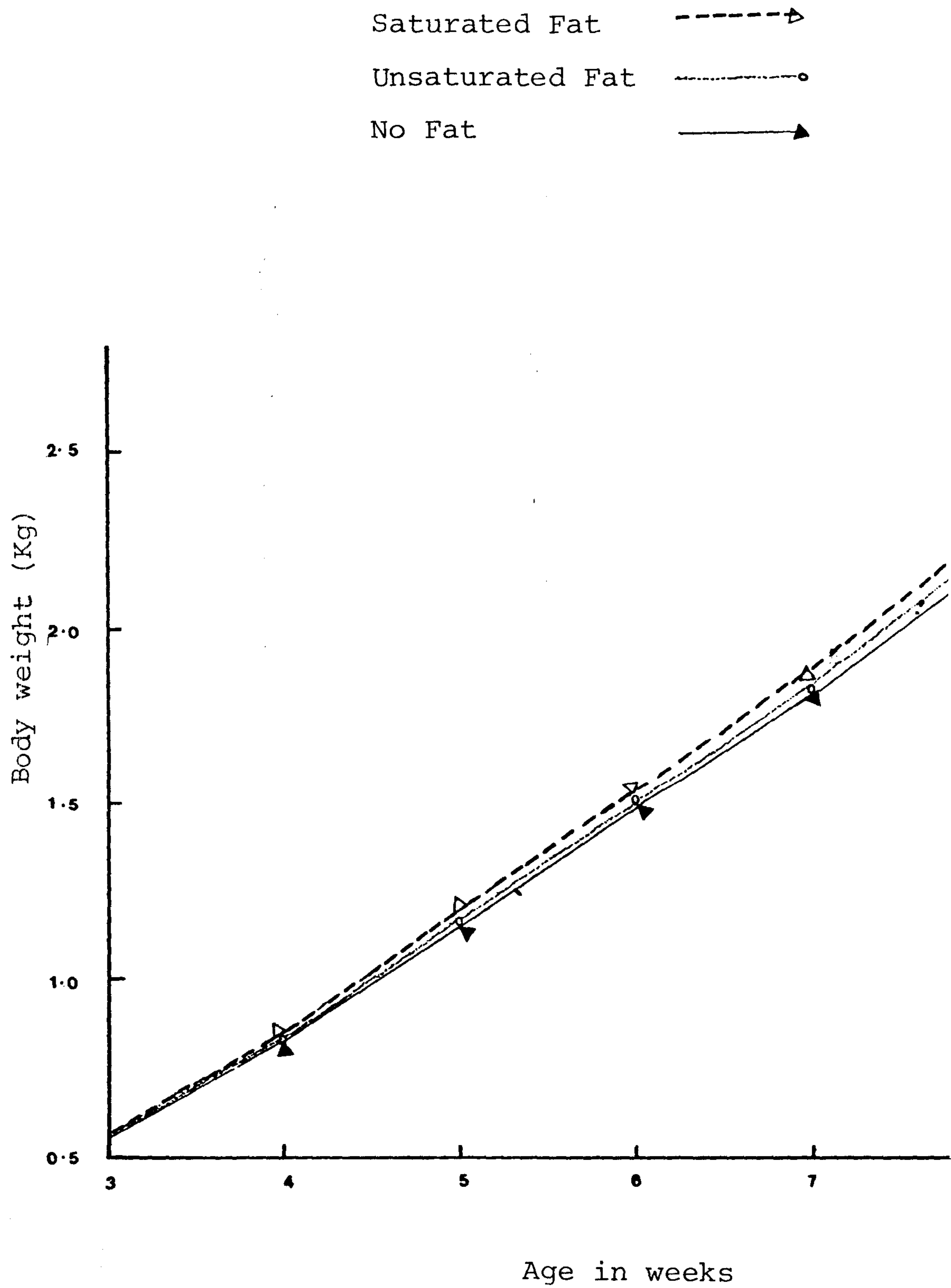
Fig : 1



Growth rate



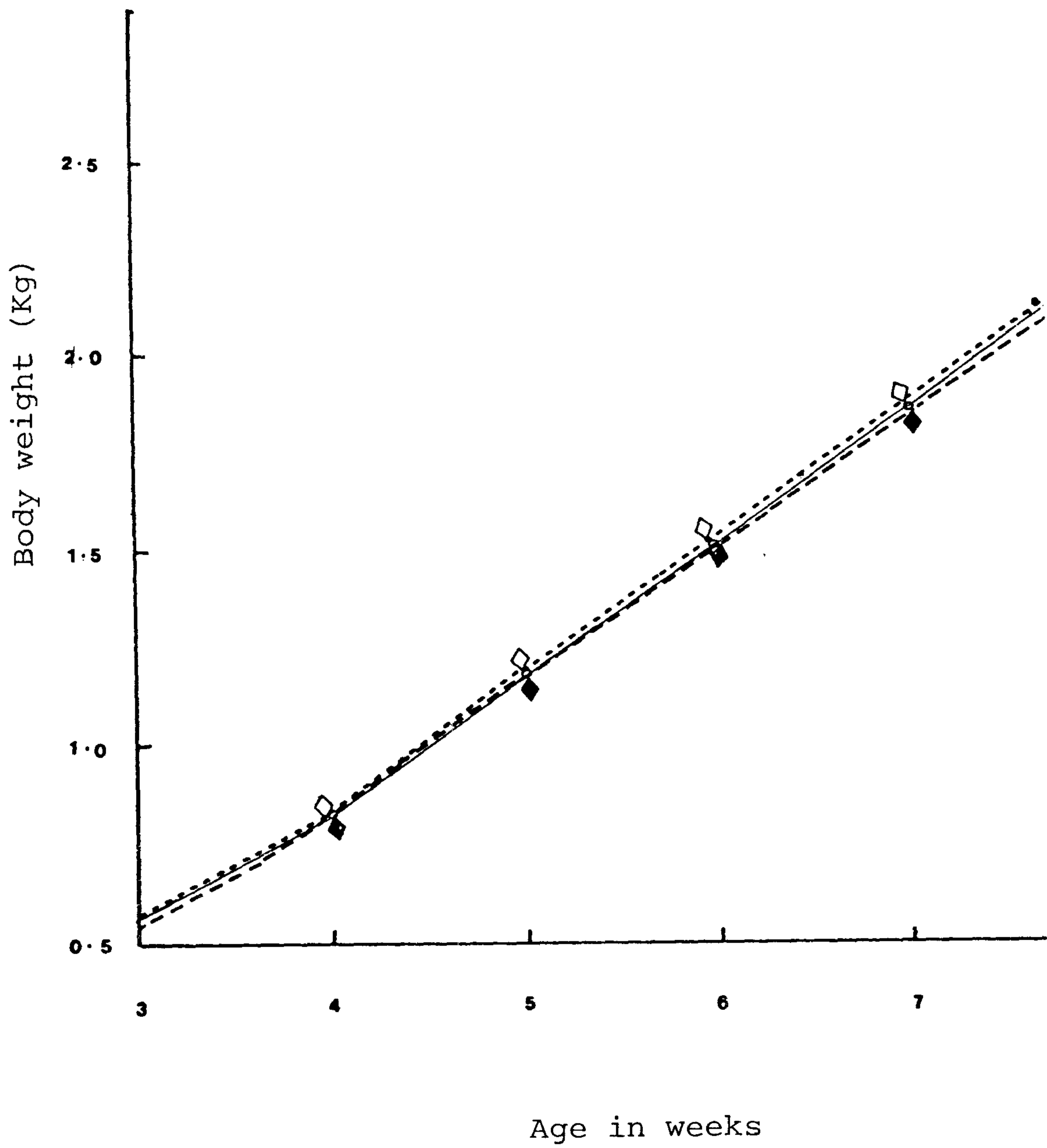
Fig. 2:



Growth rate

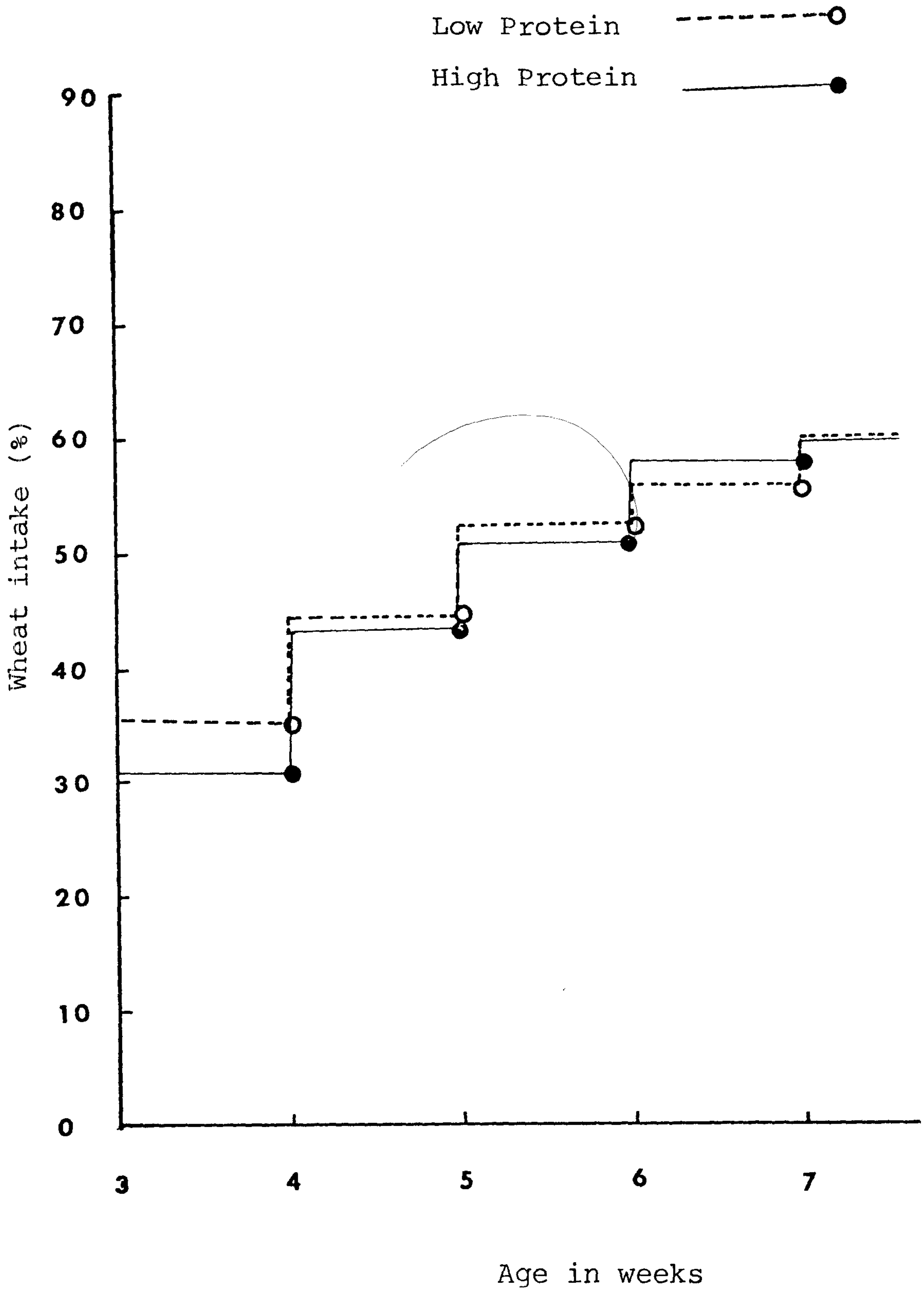
Fig. 3:

High Calcium      - - - - - ◆  
Medium Calcium    ······ ◇  
Low Calcium        ———— ○



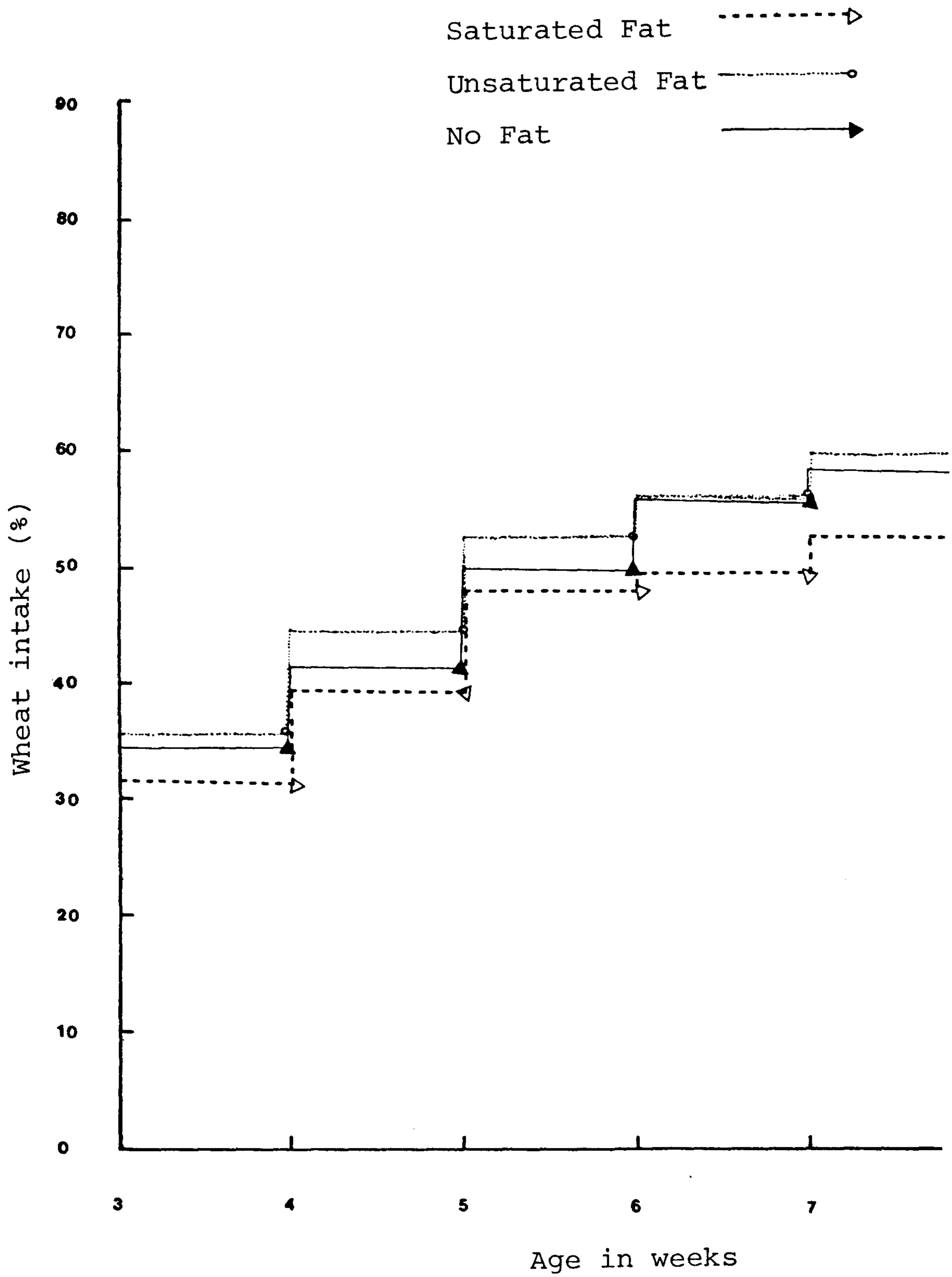
Growth rate

Fig. 4:



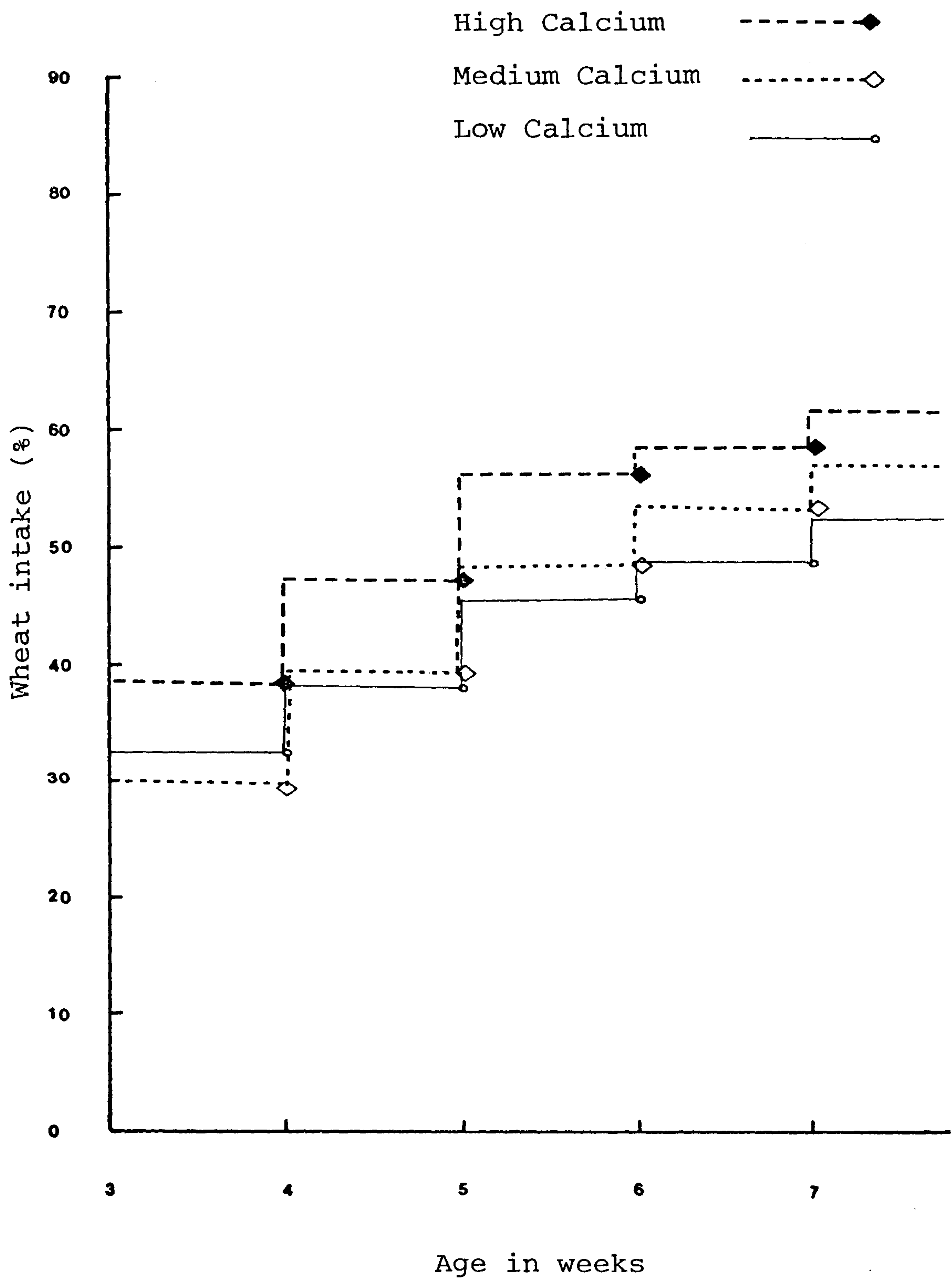
Percentage of wheat intake with balancer with different protein level

Fig. 5:



Percentage of wheat intake with balancer with different fat sources

Fig. 6:



Percentage of wheat intake with balancer with  
different calcium level

increased.

It appears that choice fed birds on the medium calcium (M. Ca) treatment utilized their food more efficiently than those on the low calcium (L. Ca) and high calcium (H. Ca) treatments. This is true under both conditions, different levels of protein and different sources of fat (Tables 4 and 5). The birds on L. Ca had to consume more balancer to compensate for calcium levels, and birds on H. Ca had to consume more wheat to change the calcium level of the diet, which resulted in a poorer food conversion in both cases.

Birds choice fed on H. Ca decreased their balancer intake and this was reflected in a poorer protein intake than with L. Ca treatments. When H. Ca and L. Ca treatments are compared with M. Ca, it can be seen that balancer consumption by the birds on L. Ca was insufficient to give an adequate intake of calcium, as it was in M. Ca treatments, while the birds on H. Ca overconsumed calcium

It seems that the birds have formed a specific hunger for calcium, but this is not the only factor influencing their food selection.

Dietary calcium at highest level was not adversely affected on weight gain and it could be reduced to the lowest level without depressing growth rate (Fig. 3). Tables 4 and 5 indicated that despite differences in calcium intake, there were no significant differences in bone mineralization and development. This result is in agreement with the finding of Lillie et al (1964), who

reported no significant differences in the percentage of bone ash of the tibia in broilers receiving different levels of dietary calcium.

It can be concluded from the results obtained that a calcium intake of 0.5 g/b/d is sufficient to support maximum growth and calcification of the bone as well as calcium intake up to 1.3 g/b/d in the broiler chicks.

Birds choice fed on whole wheat and low protein balancers (LPB) and birds on whole wheat and high protein balancers (HPB) appear to have similar growth rates. Chickens on the low protein feeds selected diets which allowed them to maintain growth rate as high as those on high protein. They consumed more food than those on HPB which was due to higher wheat intake, and reacted to a higher protein content by eating a lower proportion of wheat (Fig. 6). This finding confirms the earlier report of Emmans (1979).

It seems that birds on LPB have to increase their balancer intake to compensate for the low protein concentration of the balancer, but at the same time they have to increase their whole wheat intake to alter the calcium level owing to their higher intake of balancer (Table 5). This is reflected in a higher total food intake, and significantly poorer FCR than with the HPB treatments (Table 5).

Despite the influence of protein levels on the proportion of balancer and wheat intake it appears that calcium levels play a more effective role in dietary

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selection by chicks.

As illustrated (Table 5) there is no difference between bone growth characters at different levels of protein except bone ash, which is higher on low protein than high protein. Although it might be contrary to the general finding that calcium absorption is most efficient when the diet contains an adequate level of well-balanced protein. The result supports Biely et al (1966) who found that the bone calcification of the broiler chicks was greater on low protein diets than on high protein. They concluded that the higher calcification at the lower level of protein is associated with the lower efficiency of feed conversion and the consequently greater amounts of calcium ingested per unit increase in body weight. However, in this case no relationship between calcium ingestion and bone ash are found and the reason for differences in bone ash percentage at different levels of dietary protein is not clear.

When the birds which received no fat in their balancers (OFT) are compared with other treatments receiving either unsaturated fat (UFT) or saturated fat (SFT), birds on SFT grew most rapidly and birds on OFT grew most slowly (Fig. 2). This result shows rather clearly the differences in the ability of various fats to promote growth in the chickens. It appears that birds on SFT and UFT utilize food more efficiently than birds on OFT (Tables 2 and 4). It also supports the finding of Edwards et al (1960) that fat supplemented foods are used



more efficiently than unsupplemented food, when given to chicks. However, there were no significant differences between groups fed the various sources of fat.

From the dietary selection point of view, it seems that the birds prefer saturated fat to unsaturated fat supplemented diets. They also prefer supplemented fat to non-supplemented diets, by eating a higher proportion of balancer while no significant differences in total food intake are observed. The second part of the result is in agreement with Lewis et al (1955) who found that when birds were offered a basal diet and one supplemented with either oil or lard, the supplemented diet was generally preferred. When the birds were given a choice between lard and corn oil supplemented diets, no significant differences were observed and consumption of each diet was approximately equal. However, the first part of the present result does not support this finding.

The lack of significant differences in bone growth characteristics under different sources of fat, except bone ash which on SFT was significantly lower than on UFT, is illustrated in Table 4. This may be due to the lower calcium absorption and storage because of the presence of saturated fat in the diet, as Givens and Mendel (1917) reported. They found that the absorption and storage of calcium was decreased when saturated fat was added to the diet.

In general, food selection is apparently governed by the birds' seeking to satisfy a requirement for calci-

um by eating a higher proportion of balancer as the calcium level decreased and vice versa.

Birds on the LPB treatments had to increase balancer intake to compensate for the low protein concentration of the balancer. This was reflected in a high calcium intake, and consequently an increased wheat intake to change the dietary calcium level.

It can be concluded that female broiler chicks given a choice of food are able to select food according to their requirement for both protein and calcium to achieve maximum growth rate and to satisfy their physiological requirements. However, dietary calcium levels have a dominant effect on food selection and birds consume in response to their calcium requirement rather than protein

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نتایج بدست آمده حاکی از آن بود که پرندگان قادرند براساس نیازشان به پروتئین و کلسیم غذای خود را انتخاب نموده و جیره را متعادل کنند، لیکن در جهت تامین نیازها کلسیم را نسبت به پروتئین ترجیح می دهند.

آنها جیره های حاوی چربی های اشباع را به غیر اشباع و غذاهای حاوی چربی را بر انواع بدون چربی ترجیح می دهند.

پرندگان در گروه های مختلف غذایی با درصدهای مختلف کلسیم و پروتئین قادر بودند جیره خود را چنان متعادل انتخاب کنند که میزان رشد در تمام گروهها یکسان باشد. لیکن وزن در پرندگان تغذیه شده با جیره های حاوی چربی بیشتر از گروه های بدون چربی و در این میان تاثیر چربیهای اشباع بیش از چربی های غیر اشباع بود. علیرغم اختلافاتی که در کلسیم خورده شده مشاهده گردید در کلسیفیکاسیون و میزان رشد استخوانها تفاوتی دیده نشد. بنظر می رسد که حدود ۵/۵ گرم کلسیم برای هر پرنده در روز برای رسیدن به حداکثر رشد و کلسیفیکاسیون استخوانها کافی باشد.



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تاثیر کلسیم، پروتئین و چربی در انتخاب غذا، میزان رشد بدن و میزان رشد استخوان در جوجه های گوشتی تغذیه شده به روش آزاد.  
دکتر سید محمد مهدی کیائی\*

در این مطالعه ۱۲ نوع جیره غذایی بنام متعادل کننده Balancer با سه میزان مختلف کلسیم ( ۷/۵ و ۱۵ و ۲۲/۵ g/Kg )، دو نوع چربی (اشباع و غیر اشباع) و دو میزان مختلف پروتئین ( ۲۵۰ و ۳۰۰ g/Kg ) که هر یک نماینده یک گروه آزمایشی بودند تهیه و بصورت انتخاب آزاد همراه با دانه گندم در اختیار پرندگان قرار گرفت. ترکیب متعادل کننده های غذایی و عبارت دیگر ترکیب جیره هر یک از ۱۲ گروه بصورت زیر بود:

جیره شماره	کلسیم g/Kg	پروتئین g/Kg	چربی g/Kg
۱	۷/۵	۲۰۵	۰
۲	۱۵	۲۰۵	۰
۳	۲۲/۵	۲۰۵	۰
۴	۷/۵	۲۰۵	۵۰ غیر اشباع
۵	۱۵	۲۰۵	۵۰ "
۶	۲۲/۵	۲۰۵	۵۰ "
۷	۷/۵	۲۰۵	۵۰ اشباع
۸	۱۵	۲۰۵	۵۰ "
۹	۲۲/۵	۲۰۵	۵۰ "
۱۰	۷/۵	۳۰۰	۵۰ "
۱۱	۱۵	۳۰۰	۵۰ "
۱۲	۲۲/۵	۳۰۰	۵۰ "

بررسی بر روی ۴۵۰ قطعه جوجه گوشتی ماده ۲۱ روزه از سویه تجارتي Ross که در ۳۶ قفس توزیع گردیده و هر ۱۲ قفس موجود در یک طبقه یک بلوک، و تکرار به حساب می آید انجام گرفت.

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