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Effect of supplementation of laboratory chow with leaf of *Rumex acetosa* (sorrel) on body weight and serum levels of amino acids and minerals in rat

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The biological value of *Rumex acetosa* (sorrel) leaf was assessed in rats by comparing the weight gained and serum levels of amino acids and minerals in rats fed standard laboratory diet with those of rats fed laboratory chow mixed with the leaf in the proportion of 20% or 50%. Each diet adequately supported growth, with progressive gain in weight being recorded in each case. At the end of the fifth week, the growth rates of rats fed 50%-supplemented diet were significantly higher ($P < 0.05$) than those of rats fed 20%-supplemented or control diets. The high fibre content in the leaf did not seem to affect bioavailability of dietary amino acids and minerals as shown by the almost identical serum profiles of total protein, amino acids and minerals in test and control rats. The significant weight gain observed in rats fed 50%-supplemented diet, compared with the control rats, suggests that the leaf is of high nutritive value. © 1997 Published by Elsevier Science Ltd. All rights reserved

INTRODUCTION

Our previous studies (Ladeji & Okoye, 1993) have shown that sorrel (*Rumex acetosa*) leaf has relatively high crude protein (25.0 g per 100 g) and crude fibre (13.0 g per 100 g) contents. However, the biological value of the leaf protein and the physiological effects of the fibre were not determined. Growth rate has been shown to be a good index of biological value of leaf protein, and a leaf protein which produces a weight gain of about 25 g in 4 weeks, when fed to rats as the sole source of dietary protein, is considered a good-quality leaf protein (Subba Rau *et al.*, 1972). Leafy vegetable fibre is known to affect bioavailability of dietary protein, zinc, iron and calcium (Sandberg, 1991; McCance & Widdowson, 1935). The present work was designed to assess the biological value of the leaf protein as determined by growth rate and serum amino acid levels, and also to assess the physiological effect of the leaf fibre, using serum mineral levels as indices. For the assessment of biological value, the leaf is incorporated into standard laboratory chow.

MATERIALS AND METHODS

Materials

Sorrell (*R. acetosa*) leaf was bought from various markets in Jos, Plateau State of Nigeria, and prepared as previously reported (Ladeji & Okoye, 1993). Laboratory chow was purchased from Pfizer Feeds, Nigeria, Limited, Lagos. The protein, fat and fibre content of laboratory chow as bought were 21%, 2.5% and 6%, respectively. These values were confirmed before use.

Preparation of 20% and 50% leaf-supplemented diets

For the 20%-supplemented diet, 20 g of dried powdered leaf (protein 25%, fat 3%, fibre 13%) were mixed with 78 g of laboratory chow in a bowl. Warm water was added and the preparation mixed thoroughly until homogeneous. The mixture was hand-rolled, put in a tray and dried in an oven maintained at 45–50°C until completely dried. The 50%-supplemented diet was prepared by mixing 50 g of the leaf with 42 g of laboratory chow and treating as for the 20% diet.

Feeding experiment

One hundred and twenty male albino rats (Wistar strain) weighing 50–60 g were distributed evenly into 15 standard plastic cages (eight rats per cage). The cages were kept in the animal house with the temperature maintained at 30–40°C. Rats in the first five cages (A–E) were fed with 20%-supplemented diet, those in the next five cages (F–J) were fed the 50%-supplemented diet, while the rats in the remaining five cages (K–O) served as control. The amount of feed was controlled such that

Table 1. Effect of 50% leaf-supplemented diet on serum level of amino acids (mg per 100 ml)

		Ileu	Leu	Lys	Met	Thr	Phe	Val	Trp	Total protein (g per 100 ml)
Week 1	C	0.60 ± 0.05	0.89 ± 0.08	1.0 ± 0.05	0.05 ± 0.01	1.2 ± 0.06	0.45 ± 0.02	0.50 ± 0.02	0.05	4.5 ± 0.20
	T	0.50 ± 0.04	0.76 ± 0.05	1.80 ± 0.02	0.04 ± 0.01	1.1 ± 0.05	0.43 ± 0.06	0.45 ± 0.01	0.03	3.5[b] ± 0.0
Week 2	C	0.50 ± 0.02	1.20 ± 1.10	0.80 ± 0.03	0.06 ± 0.01	0.80 ± 0.05	0.40 ± 0.08	0.40 ± 0.02	0.05	5.2 ± 0.30
	T	0.50 ± 0.0	1.20 ± 0.09	1.50[a] ± 0.04	0.05 ± 0.02	0.90 ± 0.10	0.45 ± 0.09	0.45 ± 0.02	0.05	4.8 ± 0.15
Week 3	C	0.50 ± 0.01	1.10 ± 0.08	0.78 ± 0.02	0.04 ± 0.01	1.00 ± 0.06	0.43 ± 0.07	0.30 ± 0.01	0.05	5.8 ± 0.40
	T	0.50 ± 0.01	1.30 ± 0.06	1.45[a] ± 0.07	0.06 ± 0.01	1.10 ± 0.08	0.50 ± 0.08	0.40 ± 0.02	0.04	5.9 ± 0.40
Week 4	C	0.52 ± 0.0	0.90 ± 0.05	0.76 ± 0.01	0.06 ± 0.0	1.00 ± 0.05	0.43 ± 0.05	0.40 ± 0.02	0.06	6.4 ± 0.25
	T	0.54 ± 0.02	1.0 ± 0.05	1.46[a] ± 0.02	0.07 ± 0.0	1.06 ± 0.04	0.75 ± 0.15	0.45 ± 0.01	0.06	6.3 ± 0.15
Week 5	C	0.52 ± 0.03	1.0 ± 0.0	0.75 ± 0.03	0.04 ± 0.01	1.02 ± 0.07	0.43 ± 0.04	0.45 ± 0.03	0.05	6.3 ± 0.20
	T	0.51 ± 0.02	1.0 ± 0.02	1.55[a] ± 0.04	0.07 ± 0.01	1.08 ± 0.06	0.70 ± 0.10	0.50 ± 0.02	0.04	6.1 ± 0.20

[a]Significantly higher than control ($P < 0.01$).
[b]Significantly lower than control ($P < 0.05$).
C, control rats; T, experimental rats.

rats in the three groups received the same amount of dietary protein (i.e. 4 g protein per rat per day). However, water was given to all rats *ad libitum*. Rats were fed for 5 weeks and their weights taken weekly. Rats were then sacrificed group by group weekly with their appropriate control group.

Collection and analysis of blood

Blood was collected from both the experimental and the control rats at the end of each week. Rats were killed by ether anaesthesia and blood collected by cardiac puncture. The blood was allowed to clot and serum removed after centrifugation at 4000 rpm for 10 min. Serum samples were group-pooled and stored at −20°C pending analysis. In all cases analysis was done within 24 h of collection.

Free amino acids in the serum were determined with a TSM amino acid analyser on a protein-free filtrate using the chromatographic method of Spackman and Moore (1958). Total protein was determined by the Biuret micro method as modified by Kingsley (1942), and sodium, potassium, calcium, zinc and iron were determined on diluted serum using atomic absorption spectrophotometry.

RESULTS AND DISCUSSION

The effect of sorrel leaf supplementation on body weight is presented in Fig. 1. Both the control (laboratory chow) and experimental (leaf-supplemented) diets produced an increase in body weight when fed to rats, suggesting that both diets adequately supported growth. At the end of the fifth week, the rats maintained on the 50% leaf-supplemented diet significantly gained more weight (45 ± 2.5 g) than either the control rats (37 ± 1.5 g) or the rats fed 20% leaf-supplemented diet (30 ± 1.5 g). Since all rats received the same amount of protein per day and increasing the amount of leaf incorporated significantly increased body weight (especially with 50% supplementation), it appears that the leaf protein is of good biological value and the amino acids in the leaf protein are well utilized. This deduction is supported by the nearly identical total serum protein profile (Tables 1 and 2) of the control and test groups. Similar studies have already shown that vegetables such as cauliflower, cabbage, turnip and radish have good-quality leaf proteins and induce increased weight gain when supplemented with normal rat diet (Subba Rau *et al.*, 1972; Pirie, 1975).

The effect of the 50%-supplemented diet on serum levels of cations is presented in Table 3. Except for the significantly lower level ($P < 0.05$) of potassium in the test rat at week 1, the levels of all cations determined were almost the same for both groups of rats throughout the period of feeding. The fibre concentration in the supplemented diet was twice the amount present in the control diet. This means that the experimental rats were consuming a higher fibre diet than the control rats. The observation that the serum levels of these cations were almost identical in the control and experimental rats suggests that the high fibre in the leaf of *R. acetosa* did not affect mineral utilization, and more especially zinc, iron and calcium, whose serum availability is known to be affected by dietary fibre (Erdman, 1979; Reinhold *et*

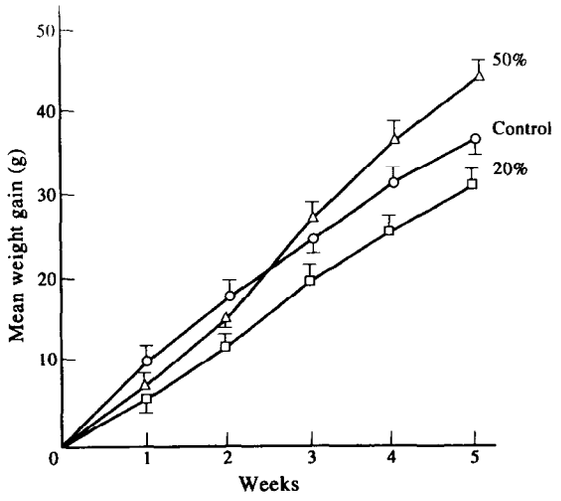

Fig. 1. Effect of leaf-supplemented diet on body weight.

Table 2. Effect of control diet on serum levels of cations (mmol litre^{-1})

		Tyr	Arg	His	Ala	Ser	Pro	Glu	Asp	Gly
Week 1	C	0.76 ± 0.02	0.50 ± 0.05	0.05 ± 0.0	0.60 ± 0.05	0.15 ± 0.02	0.20 ± 0.02	1.10 ± 0.25	0.50 ± 0.07	0.20 ± 0
	T	0.80 ± 0.02	0.50 ± 0.04	0.05 ± 0.01	0.80 ± 0.10	0.36 ± 0.01	0.21 ± 0.0	1.20 ± 0.15	0.55 ± 0.05	0.20 ± 0
Week 2	C	0.80 ± 0.03	0.30 ± 0.06	0.06 ± 0.01	0.70 ± 0.0	0.25 ± 0.0	0.18 ± 0.03	1.20 ± 0.05	0.45 ± 0.06	0.25 ± 0.01
	T	0.95 ± 0.12	0.85[a] ± 0.05	0.06 ± 0.01	0.75 ± 0.06	0.38 ± 0.02	0.20 ± 0.06	1.40 ± 0.10	0.50 ± 0.05	0.10 ± 0.01
Week 3	C	0.85 ± 0.09	0.25 ± 0.02	0.05 ± 0.01	0.65 ± 0.06	0.20 ± 0.05	0.30 ± 0.02	1.20 ± 0.08	0.40 ± 0.06	0.10 ± 0.0
	T	0.85 ± 0.04	0.70[a] ± 0.01	0.06 ± 0.02	0.80 ± 0.15	0.38 ± 0.03	0.20 ± 0.0	1.40 ± 0.09	0.45 ± 0.07	0.10 ± 0.0
Week 4	C	0.85 ± 0.08	0.25 ± 0.02	0.06 ± 0.01	0.80 ± 0.20	0.20 ± 0.0	0.30 ± 0.03	1.00 ± 0.03	0.40 ± 0.04	0.10 ± 0.01
	T	0.85 ± 0.10	0.80[a] ± 0.05	0.07 ± 0.01	0.55 ± 0.02	0.30 ± 0.0	0.20 ± 0.02	1.30 ± 0.07	0.42 ± 0.04	0.15 ± 0.01
Week 5	C	0.65 ± 0.05	0.30 ± 0.0	0.06 ± 0.03	0.65 ± 0.02	0.25 ± 0.02	0.25 ± 0.04	1.20 ± 0.06	0.40 ± 0.02	0.10 ± 0.02
	T	0.70 ± 0.05	0.80[a] ± 0.02	0.07 ± 0.02	0.80 ± 0.16	0.48 ± 0.03	0.15 ± 0.02	1.40 ± 0.08	0.40 ± 0.01	0.10 ± 0.01

[a]Significantly higher than control ($P < 0.05$).
C, control rats; T, experimental rats.

Table 3. Effect of 50% leaf-supplemented diet on serum level of cations (mmol litre^{-1})

		Na	K	Ca	Mg	Zn	Fe
Week 1	C	120 ± 6	6.4 ± 0.20	3.5 ± 0.02	1.3 ± 0.0	0.06	0.04
	T	110 ± 10[a]	3.6 ± 0.10[a]	3.0 ± 0.02	1.2 ± 0.02	0.03	0.03
Week 2	C	120 ± 6	6.7 ± 0.09	2.9 ± 0.01	0.95 ± 0.01	0.02	0.05
	T	128 ± 6	6.0 ± 0.02	2.6 ± 0.02	1.00 ± 0.01	0.01	0.04
Week 3	C	117 ± 10	6.5 ± 0.10	3.0 ± 0.04	1.0 ± 0.0	0.02	0.05
	T	119 ± 9	6.4 ± 0.20	2.9 ± 0.03	1.0 ± 0.0	0.02	0.04
Week 4	C	118 ± 8	5.5 ± 0.09	2.8 ± 0.02	1.0 ± 0.01	0.02	0.02
	T	120 ± 11	5.6 ± 0.08	2.8 ± 0.0	1.0 ± 0.02	0.02	0.02
Week 5	C	120 ± 6	5.5 ± 0.10	2.5 ± 0.10	1.0 ± 0.04	0.02	0.04
	T	120 ± 6	5.5 ± 0.10	2.4 ± 0.06	1.0 ± 0.03	0.02	0.04

[a]Significantly lower than the control ($P < 0.05$).
C, control rats; T, experimental rats.

al., 1976; Guthrie & Robinson, 1978). This will support the claim that the leaf of *R. acetosa* contains good-quality protein and the use of the leaf as a source of good protein is therefore recommended, especially in developing countries where this vegetable is available and protein deficiency is a major problem.

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