UNDERNUTRITION AND BODY COMPOSITION OF RATS

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SUMMARY

This study investigated the effects of weight loss and weight stasis on the chemical composition of carcass and non-carcass parts of rats and compared these results with previously published data for sheep subjected to similar treatments.

Weight loss and weight stasis in rats had vastly different effects on the chemical components of both parts compared to those obtained with sheep. Only non-carcass water showed a common response and it decreased during both treatments. Within either weight loss or weight stasis, the response of some chemical components varied between carcass and non-carcass parts. These variations emphasise the value of separate carcass and non-carcass analyses for a more precise definition of body composition.

INTRODUCTION

Studies with sheep have shown that both dissected carcass fat and non-carcass fat were conserved during a 75-day period of weight stasis (Murray and Slezacek 1988 a, b). The results of these studies were confirmed by Aziz and Murray (1987) who found that the chemical fat content of both carcass and non-carcass parts of sheep was not only conserved but actually increased after an identical period of weight stasis. Murray and Aziz (1987) also demonstrated that the chemical fat content of carcass or non-carcass parts of sheep was greater in animals after a 75-day period of weight loss compared to that in continuously grown animals of the same liveweight.

The primary aim of this study was to determine whether weight stasis and weight loss had similar effects on the chemical composition of the carcass and non-carcass parts of rats to those reported for sheep by Aziz and Murray.

EXPERIMENTAL METHODS

Twenty female Wistar type rats were used in the study. They were obtained at three weeks of age (weaning) from five litters with four rats selected from each litter. The four rats from each litter were randomly allocated to one of the following four groups. Control Group A which were fed *ad libitum* from weaning until they reached a slaughter weight of 100 g. Control group B which were also fed *ad libitum* from weaning until 100 g and then were fed to grow at 3 g/d until their slaughter weight of 150 g. The weight stasis and weight loss groups were treated in an identical manner to control group B until they reached 150 g. After attaining this weight, the weight stasis group were fed to maintain this weight for 50 days and then slaughtered. The weight loss group were fed a restricted ration to lose 50 g body-weight over 50 days and then slaughtered. The weight loss group were fed a restricted ration to lose 50 g body-weight over 50 days and were slaughter at 100 g.

All rats were individually caged in a room maintained at 21°C with a 12 h light-dark cycle. Animals were fed daily at 08.00 to 09.99 h and weighed at least every other day so that individual growth paths were maintained by appropriate feed adjustments. Water was available at all times. A standard laboratory chow was fed to all animals which contained 89.3% dry matter and 23.17% crude protein, 3.56% crude fibre and 3.13% crude fat, all on a dry matter basis.

Rats were slaughtered at designated times in a wool conditioning room maintained at 21°C and 65% relative humidity. Each rat was anaesthetised with ether and then bled by cutting its throat. Digesta and urine were removed and the carcass and on-carcass parts were separated, weighed, placed in plastic bags and stored at -20°C for subsequent chemical analyses.

Both carcass and non-carcass parts were prepared for chemical analyses by grinding them in a small feed mill (sieve plate 3 mn diameter holes) after they had been immersed in liquid nitrogen (-196°C). Ground material was stored at -20°C and subsequently analysed for water,

Table 1. Effects of weight loss on the mean weight (standard deviation) of carcass, non-carcass and chemical components

Component	Control group A (g)	Loss group (g)	Difference†
Carcass wt.	42.31 (1.288)	46.34 (1.371)	**
Water	29.84 (1.116)	31.98 (0.770)	**
Protein	9.29 (0.466)	10.68 (0.671)	**
Fat	1.37 (0.868)	0.61 (0.168)	NS
Ash	2.13 (0.124)	3.62 (0.186)	***
Non-carcass wt.	45.08 (1.336)	41.71 (1.218)	**
Water	29.29 (1.121)	25.63 (1.070)	***
Protein	10.67 (0.251)	12.57 (0.356)	***
Fat	5.29 (0.384)	1.68 (0.472)	***
Ash	1.91 (0.116)	3.05 (0.064)	***

† ** $P < 0.01$, *** $P < 0.001$, NS Non-significant $P > 0.05$

Table 2. Effects of weight stasis on the mean weight (standard deviation) of carcass, non-carcass and chemical components

Component	Control group B (g)	Stasis group (g)	Difference†
Carcass wt.	66.11 (1.746)	74.44 (3.171)	***
Water	45.87 (1.644)	51.32 (2.323)	**
Protein	14.30 (0.750)	17.02 (0.579)	***
Fat	2.95 (0.921)	2.10 (0.829)	NS
Ash	3.26 (0.177)	4.14 (0.255)	***
Non-carcass wt.	65.30 (1.593)	57.26 (3.206)	**
Water	37.50 (0.810)	33.60 (1.687)	**
Protein	14.83 (1.010)	15.63 (0.549)	NS
Fat	11.73 (1.850)	6.05 (1.811)	**
Ash	2.66 (0.161)	3.05 (0.064)	**

† ** $P < 0.01$, *** $P < 0.001$, NS Non-significant $P > 0.05$

crude protein (N x 6.25), fat and ash using duplicate samples and conventional methods.

Mean weights for carcass and non-carcass parts and their respective chemical components in the weight loss group were compared with the appropriate mean weights for the control group A using Student's *t*-test. Likewise data for the weight stasis group were compared to those for the control group B.

RESULTS

Weight loss

There were significant differences between the control and weight loss groups in carcass and non-carcass weights and in the chemical composition of each part as shown in Table 1.

The weight statis treatment was associated with an increase in carcass weight and a decrease in non-carcass weight although mean slaughter weight (standard deviation) was similar in control 100.9 (3.6), and weight loss 100.7 (1.5) g, rats.

The separate weights of water, protein and ash were greater in the carcasses of weight loss rats but carcass fat was not different in the two groups. The non-carcass parts of rats after weight loss contained more protein and ash but less water and fat compared to control values.

Weight stasis

The effects of weight stasis on carcass and non-carcass weights and the chemical composition of each part are illustrated in Table 2.

Weight stasis produced an increase in carcass weight and a decrease in non-carcass weight despite the similarity of mean slaughter weight (standard deviation) in control 150.5 (2.5), and weight stasis 149.9 (2.4) g, rats.

The carcasses of weight stasis rates contained more water, protein and ash than those of control rats. Carcass fat content was similar in the two groups. The non-carcass parts of weight stasis rats contained more ash but less water and fat compared to values for control rats. Non-carcass protein content was unaffected by weight stasis.

DISCUSSION

The responses of carcass and non-carcass weight to weight loss were identical in sheep and rats. In both species carcass weigth was heavier after weight loss and non-carcass weight was lighter (Murray and Aziz 1987; Table). Chemical anlyses of both these parts, however, revealed only one common response, namely, that water content of non-carcass parts was reduced by weight loss. Comparative responses of other chemical components were as follows. Both carcass and non-carcass fat were increased in sheep but were unaffected and decreased, respectively, in rats. Carcass and non-carcass protein were unaffected and decreased, respectively, in sheep while both increased in rats. Carcass water content was unaffected by weight loss in sheep but was increased in rates (Murray and Aziz 1987; Table 1).

Ash analyses were not conducted by Murray and Aziz (1987) but the primary source of their data (Aziz 1988) reported significant increases in both dissected carcass bone and combined head and feet weight of their sheep after weight loss. These increases suggest that the ash content of both the carcass and non-carcass parts of their sheep may also have been greater after weight loss like the rats here (Table 1).

Weight stasis

As was the case in the study of Aziz and Murray (1987) with sheep, weight stasis of rats here was associated with an increase in carcass weight and a decrease in non-carcass weight (Table 2). The results of chemical analyses of both carcass and non-carcass parts showed one common response compared to those for sheep. This was that the water content of non-carcass parts was reduced after weight stasis. Comparative responses of other chemical components varied in the two species as follows. Both carcass and non-carcass fat were increased in sheep but were unaffected and decreased, respectively, in sheep and increased and unaffected, respectively, in rats. Carcass water content was unaffected by weight stasis in sheep while it was increased in rates (Aziz and Murray 1987; Table 2).

Aziz and Murray (1987) did not measure ash content of their animals. Data reported by Aziz (1988), however, for these same animals suggest that ash content of carcass and non-carcass parts may b\have increased during weight stasis. Aziz reported that both dissected carcass bone and feet weight increased significantly after weight stasis. If these suggested increases in ash did in fact occur, they would conform with corresponding increases in ash observed here in rats (Table 2).

Some general considerations

It is obvious from the results discussed above, that equivalent restricted growth paths in sheep and rats produced very different changes in the chemical components of the carcass and non-carcass parts. Moreover, little further agreement of results in the two species was found when rat data were analysed on a whole body basis (not shown) and compared with fleece-free empty body data for the sheep (Aziz and Murray 1987; Murray and Aziz 1987). Comparisons of water, fat and protein during both weight loss and weight stasis revealed a single common response, namely, that whole body water content was unaffected by weight stasis.

These further analyses of rat data on a whole body basis highlighted the following important points. First, that decreases in whole body fat during both weight loss and weight stasis and an increase in whole body protein during weight stasis could be ascribed to significant changes in non-carcass fat and carcass protein. Second, there was no change in whole body water during either weight loss or weight stasis.

These further analyses of rat data on whole body basis highlighted the following important points. First, that decreases in whole body fat during both weight loss and weight stasis and an increase in whole body protein during weight stasis could bs ascribed to significant changes in non-carcass fat and carcass protein. Second, there was no change in whole body water during either weight loss or weight stasis as the increase in carcass water during each treatment was cancelled out by a decrease in non-carcass water. These observations emphasise the benefit of conducting separate analyses of

carcass and non-carcass parts for a more precise appreciation of changes in body composition.

CONCLUSION

1. Weight loss and weight stasis in rats produced different effects on the chemical composition of carcass and non-carcass parts compared to those reported for sheep.

2. During both weight loss and weight stasis, the patten of response of particular chemical components differed between carcass and non-carcass parts. These differences suggest that separate analyses of both parts may provide a more accurate definition of compositional changes than whole body analyses.

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