# NITROGEN NUTRITION OF BRANT (BRANTA BERNICLA L.) GRAZING ON SALTMARSH AND PASTURE SPECIES

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**ABSTRACT**
Captive brant *Branta bernicla* were fed a range of food plants to determine their ability to digest nitrogen and specifically soluble protein. Soluble protein levels in droppings were only a small fraction of those in plants, indicating substantial uptake or conversion. For white clover *Trifolium repens* L., uric acid content indicated that at least 50% of excreted nitrogen had been metabolised, strongly suggesting that a substantial fraction of soluble protein is utilised by the geese. Carbon/nitrogen ratios increased from plants to droppings while carbon/hydrogen ratios remained nearly constant indicating greater uptake of nitrogen relative to carbon. *T. repens* was found to contain the highest soluble protein and total nitrogen contents of the four plant species tested.

**KEYWORDS**
Herbivory, geese, *Branta bernicla*, nitrogen, protein, nutrition, digestion

## INTRODUCTION

Most goose species are predominantly herbivorous but do not possess specialised mechanisms for digesting structural plant material. Instead, they rely on rapid processing of large amounts of food to meet their energy and nutrient requirements (Sibly, 1981).

Many wintering goose populations now feed to some extent on agricultural land, causing a conflict of interest between farmers and conservationists. One solution to this problem is the establishment of alternative feeding areas (Owen, 1990), the effectiveness of which will depend largely on the suitability of the plant species grown for goose grazing. Determining which plant species provide the highest uptake of energy and nutrients is therefore important.

Previous studies have shown that geese select plants with a high digestibility (Boudewijn, 1984) and those which contain high levels of nitrogen (Vickery et al., 1994). This paper examines the nitrogen utilisation of a range of potential food plants by captive brant (*Branta bernicla* L.). It assesses the importance of soluble protein as a source of nitrogen to the brant.

## MATERIALS AND METHODS

Feeding trials were carried out with eight captive adult black brant *B. b. nigricans* at the Wildfowl and Wetlands Trust Centre, Washington, UK from November 15 to December 8, 1995.

The plant species used in this study were common saltmarsh-grass (*Puccinellia maritima* (Hudson) Parl.), a naturally-occurring food plant of brant on European saltmarshes, perennial rye grass (*Lolium perenne* L. cv. Talbot) and white clover (*Trifolium repens* L. cv. Grasslands Huia), both pasture species eaten by brant and other geese) and Caucasian clover (*T. ambiguum* M. Bieb. cv. Alpini), a potential alternative to white clover. Pasture species were grown from seed in 40 x 20 x 6 cm plastic seed trays for six months prior to the experimental work. The growing medium was John Innes No. 2 compost (J. Arthur Bower's, Lincoln, UK) and plants were cut twice to encourage an increase in shoot density. Turves of *P. maritima* were cut from sheep-grazed saltmarsh at Lindisfarne National Nature Reserve, UK, and placed in trays, immediately before the experimental period.

Individual birds were given six trays of one food plant in an indoor pen and allowed to feed undisturbed for six hours (0900 to 1500 hours). Before a feeding trial, birds were not fed for 24 hours, to ensure that all droppings from the feeding trial were produced from the relevant food plant. After a feeding trial each bird was allowed to feed freely on its normal grass/grain diet for two days before starting another trial.

At the end of each trial, all droppings were collected and stored at -20°C. For each plant species, fresh samples from ungrazed trays were cut to mimic goose grazing. Food plant and dropping samples were assayed for soluble protein (Read and Northcote, 1981). Carbon, hydrogen and nitrogen contents of oven-dried (60°C) samples were measured using a Carlo Erba 1106 CHN Elemental Analyser (Strumentazione, Milan, Italy). The dry weight percentage of nitrogen due to soluble protein was estimated by dividing the dry weight percentage of soluble protein by 6.25 (Allen, 1989). Percentage data were converted to proportions and arcsine-transformed before analysis.

For *T. repens*, uric acid content was measured in plants and droppings. Uric acid was extracted in 100 mol/m$^3$ sodium phosphate and determined using standard assay kits (Sigma Chemical Company Ltd, Poole, UK). Results are expressed as the percentage of nitrogen due to uric acid.

## RESULTS AND DISCUSSION

Previous studies on nitrogen nutrition in geese have determined either 'crude protein' contents from a measure of total nitrogen (e.g. Vickery et al., 1994) or measured total protein levels (e.g. Buchsbaum et al., 1986). This paper used a direct measure of soluble protein as this was likely to be one of the most easily digested forms of nitrogen available to the geese (Parra, 1978).

Table 1 shows that nitrogen levels decreased from plants to droppings. Soluble protein accounted for a major proportion of the nitrogen in the food plants (35%-63%) and the percentage content dropped dramatically from food to droppings in all four species. This indicates that the majority of nitrogen from soluble protein in plants was taken up by the geese or converted to other compounds in the gut and excreted. This fits with the previous results showing high digestibility of total protein (61-80%; Buchsbaum et al, 1986).

Uric acid nitrogen content in *T. repens* droppings was 1.22 ± 0.05 (SE) % of total dry weight and in plants; 0.024 ± 0.001 (SE) %. Uric acid therefore accounted for 50.8 ± 4.2 (SE) % of the total excreted nitrogen. As the levels of uric acid in the plants were negligible this implied that at least 50% of excreted nitrogen had been metabolised into a specific nitrogenous waste product rather than being converted in the gut and excreted. This provides strong evidence that a substantial proportion of soluble protein in the food plants was being utilised. Further studies into the importance of free amino acids in this system will help to clarify this.

Carbon/nitrogen (C/N) ratio increased from plants to droppings in all plant species (Table 1). This indicates that more nitrogen relative to carbon was removed during digestion especially considering that additional carbon will be lost from the system in the form of respired $CO_2$. However, excretion of extra carbon in the form of carbonates from gizzard grit must be considered as a potential factor increasing C/N ratio. The carbon/hydrogen ratio however, remained fairly constant from food to droppings, suggesting that the bulk of excreted carbon was from undigested carbohydrate.

Table 1 shows that plant species differed significantly in nitrogen and protein content. Regardless of plant protein content, dropping protein contents were always very low. This suggests that the geese were able to remove the majority of soluble protein, even in the case of *T. repens* with a total nitrogen content much higher than the typical food of pasture-feeding brant (Vickery et al, 1994). *T. repens* was therefore probably the best food plant for the geese in terms of nitrogen uptake from soluble protein.

In this study accurate values for the digestibility of different food components could not be calculated without considering the partial digestion of the food material. Ratios between food components could be compared accurately however, assuming they originated only from the food material. Future studies will determine the overall digestibility of organic matter allowing direct comparisons to be made. The work will also extend to wild birds which may show enhanced digestive ability over captive individuals as the diet of wild birds is usually poorer (Sibly, 1981).

## REFERENCES


**Allen, S.E**. 1989. Chemical Analysis of Ecological Materials. (2nd edn) Blackwell, Oxford.

**Boudewijn, T**. 1984. The role of digestibility in the selection of spring feeding sites by Brent Geese. Wildfowl **35**: 97-105.

**Buchsbaum, R., J. Wilson and I. Valiela**. 1986. Digestibility of plants by Canada geese and Atlantic brant. Ecology 67: 386-393.

**Owen, M**. 1990. The damage-conservation interface illustrated by geese. Ibis **132**: 238-252.

**Parra, R**. 1978. Comparison of foregut and hindgut fermentation in herbivores. Pages 205-229 *in* G.G. Montgomery, ed. The ecology of arboreal folivores. Smithsonian Institution Press, Washington D.C.

**Read, S.M. and D.H. Northcote**. 1981. Minimization of Variation in the Response to Different Proteins of the Coomassie Blue G Dye-Binding Assay for Protein. Anal. Biochem. **116**: 53-64.

**Sibly, R.M**. 1981. Strategies of Digestion and Defecation. Pages 109-139 *in* C.R. Townsend and P. Callow, eds. Physiological Ecology: An Evolutionary Approach to Resource Use. Blackwell, Oxford.

**Vickery, J.A., W.J. Sutherland and S.J. Lane**. 1994. The management of grass pastures for brent geese. J. Appl. Ecol. **31**: 282-290.


**Table 1**
Concentrations of soluble protein, total nitrogen (N) and nitrogen due to soluble protein, and ratios of carbon (C) content to nitrogen and hydrogen (H) for plants and droppings. Concentrations are expressed as % of dry weight. Values quoted are means, ± SE for concentrations.

| Plant Species | Plant (P) or Droppings (D) | Soluble Protein | Total N | Soluble Protein N | C/N ratio | C/H ratio |
|---|---|---|---|---|---|---|
| *P. maritima* | P (n=6) | 13.1 ± 0.3[a] | 4.9 ± 0.2[a] | 2.1 ± 0.05[a] | 9.2[a] | 7.17 |
| | D (n=8) | 0.5 ± 0.1[x] | 2.0 ± 0.4 | 0.1 ± 0.01[x] | 19.4 | 7.06[a] |
| *L. perenne* | P (n=6) | 11.2 ± 0.4[a] | 5.1 ± 0.1[a] | 1.8 ± 0.07[a] | 7.5[b] | 7.69 |
| | D (n=8) | 0.6 ± 0.1[x] | 2.0 ± 0.2 | 0.1 ± 0.01[x] | 15.6 | 7.24[b] |
| *T. repens* | P (n=6) | 22.0 ± 0.6[b] | 6.2 ± 0.1[b] | 3.5 ± 0.09[b] | 6.7[b] | 7.1 |
| | D (n=8) | 1.5 ± 0.1[y] | 2.5 ± 0.2 | 0.3 ± 0.02[y] | 13.8 | 6.94[a] |
| *T. ambiguum* | P (n=6) | 16.3 ± 0.9[c] | 4.2 ± 0.1[c] | 2.6 ± 0.14[c] | 10.1[a] | 7.18 |
| | D (n=4) | 0.9 ± 0.1[x] | 1.8 ± 0.1 | 0.2 ± 0.02[x] | 18.6 | 7.05[a] |

[a,b,c,x,y] Within a column, for each category (plants or droppings), values with different superscripts are significantly different (one-way ANOVA, p<0.001, Tukey's multiple comparison tests, p<0.05). Column categories without superscripts have no significant differences.