
VOLUME 62 2002

Proceedings of the N.Z. Society of Animal Production, 41: 248-253 (1981)

NUTRITIONAL "TAPERING" OF FARM LIVESTOCK

K. T. JAGUSCH and J. F. SMITH
Ruakura Agricultural Research Centre, Hamilton
P. V. RATTRAY
Whatawhata Hill Country Research Station, Hamilton

SUMMARY

Nutritional "tapering" is defined using aerobic training of athletes as an example. Experiments are listed where livestock performance either has depended or appears to be related to nutritional pre-conditioning and subsequent better feeding. The subject is discussed with reference to metabolic changes that occur when nutritional "tapering" is practised.

DEFINITION

The purposeful alteration of dietary intake, composition, food quality, or pattern of feeding to produce an alteration in metabolism and thereby better performance is known as nutritional "tapering". An example is the aerobic training of athletes: athletes are given diets relatively low in carbohydrate but containing extra quantities of fat. The fat is then withdrawn, sometimes in association with a short fast, and carbohydrate is increased several days before racing. This programme allows surplus glycogen to accumulate in muscle (physiological overshooting) and delays the onset of exercise fatigue brought about through the disturbance of central nervous system regulation with the peripheral exhaustion of glycogen and drop in blood sugar. This increases stamina (Fig. 1). Furthermore, aerobic training and biasing nutrition, such that free fatty acid oxidation contributes more significantly to the regeneration of energy-containing compounds, increases the efficiency with which stored carbohydrate can be used, besides increasing cardiac efficiency and the ability to withstand large oxygen debts (Lydiard, 1975). Under these conditions increased activity of enzymes associated with glucose metabolism are apparent (Simonsen 1971). "tapering" thus results in performance above and beyond the normal.

EXPERIMENTAL EXAMPLES OF NUTRITIONAL "TAPERING"

There are many examples where livestock have been nutritionally "tapered" both intentionally and inadvertently. The following have been selected largely from our experiments:

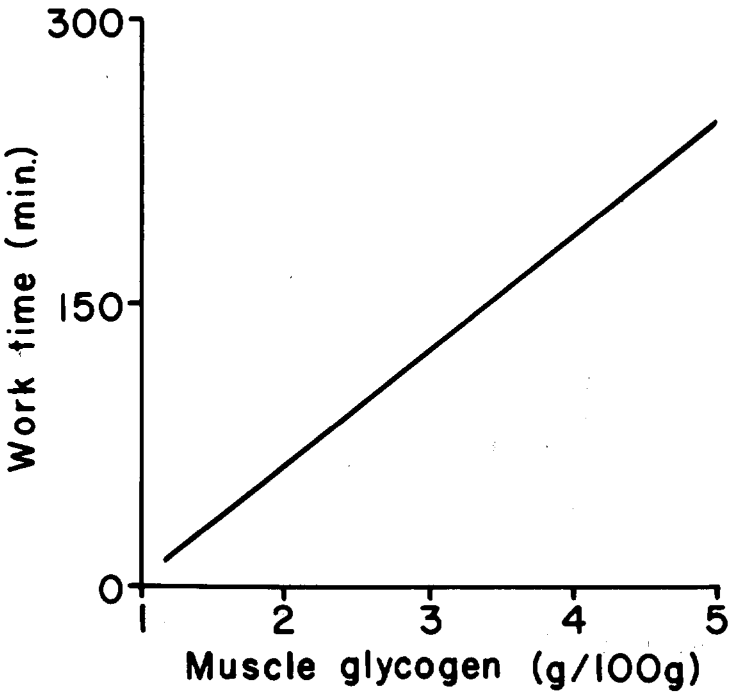

FIG. 1: *The relationship between level of muscle glycogen and stamina for work.*

1. The greater incremental response in ovulation rate of flushed light ewes compared with heavy ewes, has been a feature of the experiments of Rattray *et al.*, (1980a, b). Light ewes were obtained by either store feeding or restricting their nutrition for several weeks prior to flushing, while heavy ewes gained weight continuously. During flushing light ewes rapidly gained weight. However, ovulation rates physiologically 'overshot' in respect to tupping liveweight and the response to flushing diminished as ewes got heavier (Fig. 2).
2. In Southland both K. F. Thompson and M. Harbord (pers. comm.) have indications that above average lambing percentages occur when ewes go through a store feeding period in late summer, followed by good autumn feeding, compared with normal seasons of continuous good feed supply due to adequate summer rainfall.

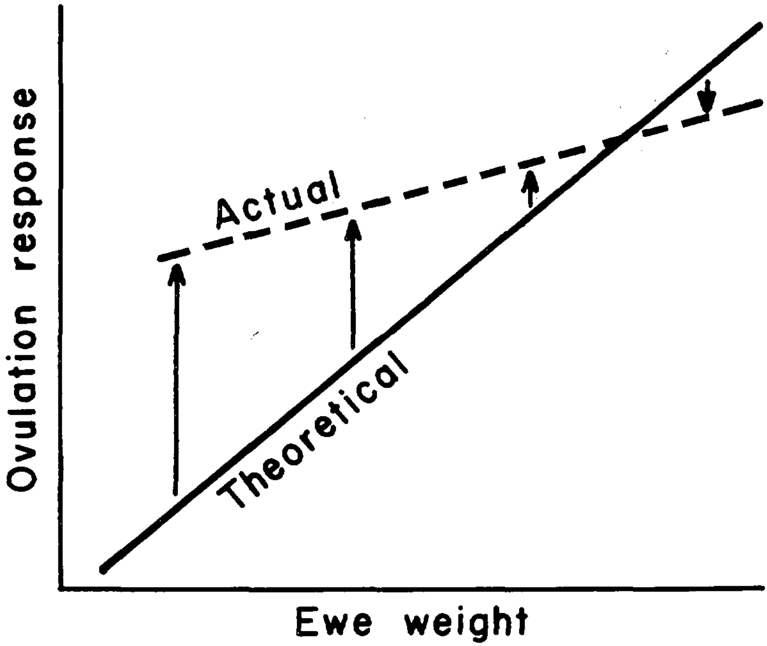

FIG. 2: *The theoretical and actual ovulation response to flushing ewes.*

3. Supplementation of sheep on dry summer pastures with lupin grain has substantially increased ovulation rates and lambing percentage without changing liveweight (Knight, 1980; Knight *et al.,* 1975; Lightfoot and Marshall, 1975). Initially it was considered that lupins corrected a protein insufficiency (Lindsay, 1976) as supplementation of diets already adequate in protein gave no response (Rizzoli *et al.,* 1975; T. W. Knight, pers. comm.) and no response was found with wheat and wheat plus urea supplementation (Reeve *et al.,* 1975). More recent work (Lindsay *et al.,* 1980) suggests the response is due to improved nutrient supply and utilisation rather than protein *per se.* Nutritional "tapering" in these studies is therefore readily apparent because nutritional preconditioning is essential to the response.
4. "Tapering" effects were shown in our mid-pregnancy experiments (Table 1) where groups of ewes were initially given different levels of nutrition and then all fed well (1.5 x maintenance) 5 weeks prior to parturition. In terms of lamb birth weight and milk yield both the light and heavy ewes that

initially made up the less well-fed groups did equally as well as those that gained weight in mid-pregnancy relative to their respective liveweights at parturition.

TABLE 1: PERFORMANCE OF LIGHT AND HEAVY EWES FED AT DIFFERENT LEVELS OF NUTRITION AT PASTURE IN MID-PREGNANCY.

	Liveweight gain mid-pregnancy (kg)		*Liveweight at parturition (kg)*		*Lamb birth weight (kg)*		*Milk production (l/d)*	
Level of Nutrition	*Light*	*Heavy*	*Light*	*Heavy*	*Light*	*Heavy*	*Light*	*Heavy*
Very low	−1.5	−6.4	57	55	4.5	4.4	1.9	2.0
Low	1.2	−1.8	59	59	4.6	4.5	1.7	2.3
Med.	3.9	1.9	61	60	4.8	4.5	1.8	2.1
High	8.0	2.3	63	61	4.7	4.5	1.9	2.2
Very High	10.7	3.8	64	62	4.7	4.4	1.9	2.1

Initial Liveweight: Light = 50 kg, Heavy = 57 kg

5. Differential feeding of groups of ewes 5 weeks prior to parturition such that 13 kg liveweight differences were generated by lambing (Table 2) gave differences in lamb birth weights but affected milk yield and weaning weight little when all groups subsequently were fed at high pasture allowances. Ewes at the lowest planes of nutrition went through a period of restricted nutrition because they accommodated conceptus growth at the expense of body reserves and still produced similarly to those well-fed in late pregnancy.
6. Nutritional "tapering" is also evident in all studies on compensatory growth (cf. Thornton *et al.,* 1979; Gingins *et al.,* 1980) and in the United Kingdom hill farm improvement schemes using two-pasture management systems (Cunningham and Russel, 1979).

DISCUSSION

Emphasis in the past has been given to the importance of matching livestock requirements to seasonal pasture supply. Management strategies such as the timing of drying-off lactating stock, the sowing of improved winter and summer growing pasture species, breeding to the spring flush, conservation of surplus grass, and the use of weaned cows and ewes for pasture control purposes, have been adopted to achieve an effective match. It seems that livestock

TABLE 2: PERFORMANCE OF 55 kg EWES FED AT DIFFERENT LEVELS OF NUTRITION IN LATE PREGNANCY (kg)

Late pregnancy herbage allowance (DM/head/d)	*Liveweight gain late pregnancy*	*Lamb birth weight*	*Milk yield*	*Lamb Weaning weight*
0.7	1.5	4.7	2.2	21
1.0	3.4	4.7	2.0	20
1.4	5.8	4.9	2.2	21
2.0	11.0	5.0	1.9	20
3.0	12.1	5.0	2.0	21
4.0	14.4	5.1	2.3	22

essentially require nutritional preconditioning and to thus be "tapered" during their reproductive-lactation cycle in order to achieve high individual performance, but this has never been considered as an integral part of animal requirements.

Furthermore, when requirements are discussed, a gross weight value is usually used as reference. Such a reference however, is relatively insensitive because "tapering" results in important changes in the animal's metabolism. For example, alterations occur in volatile fatty acid production and acetate tolerance (Reid, 1958; Jarrett and Filsell, 1960; Egan, 1965; Weston, 1966) enzyme concentrations and activities (Kronfield, 1965; Simonsen, 1971; Manns, 1972), hormone regulation and output (Reid, 1960; Leng, 1965; McManus *et al.,* 1972; Trenkle, 1974; Bassett, 1975; Brien *et al.,* 1976), the composition of the loss or gain in weight (Drew, 1973; Drew and Reid, 1975a, b), the distribution of fat depots (Thornton *et al.,* 1979), and the contribution to energy metabolism of different biochemical pathways (Bergman, 1971; Simonsen, 1971). No doubt cell concentrations of metabolites and electrical gradients are also affected, thus altering the kinetics of membrane transfers. By the same token, preconditioned animals are very susceptible to toxic insult such as that from carbon tetrachloride (Manns, 1972).

The basic reason for "tapering" responses, particularly in regard to a preconditioning store feeding regime, may revolve around the change from a ketogenically biased metabolism to one of gluconeogenesis. Here the analogy to athletes in training becomes even more pertinent. Within the routine of grassland agriculture livestock regularly "taper" themselves to accommodate season by season changes in grass growth brought about largely by rainfall. Since our experiments have consistently established that livestock respond to "tapering", recognition can be given to nutritional preconditioning as a management strategy essential for high per head performance.

REFERENCES

Bassett, J. M., 1975. In *Digestions and Metabolism in the Ruminant.* (Eds. I. W. McDonald and A. C. I. Warner) University of New England, p. 383.

Bergman, E. N., 1971. *J. Dairy Sci., 54:* 936.

Brien, F. D.; Baxter, R. W.; Findlay, J. K.; Cumming, I. A., 1976. *Proc. Aust. Soc. Anim. Prod., 11:* 237.

Cunningham, J. M. M.; Russel, A. J. F., 1979. *Livestock Prod. Sci., 6:* 379.

Drew, K. R., 1973. *Proc. N.Z. Soc. Anim. Prod., 33:* 184.

Drew, K. R.; Reid, J. T., 1975a. *J. agric. Sci., Camb., 85:* 205.

____________ 1975b. *J. agric. Sci., Camb., 85:* 218.

Egan, A. R., 1965. *Aust. J. agric. Res., 16:* 473.

Gingins, M.; Bickel, M.; Schurch, A., 1980. *Livestock Prod. Sci., 7:* 465.

Jarrett, E. G.; Filsell, O. H., 1960. *Aust. J. exp. Biol. med. Sci. 38:* 347.

Knight, T. W., 1980. *Proc. N.Z. Soc. Anim. Prod., 40:* 38.

Knight, T. W.; Oldham, C. M.; Lindsay, D. R., 1975. *Aust. J. agric. Res., 26:* 567.

Kronfeld, D. S., 1965. *Nord. Vet. Med., 17:* 182.

Leng, R. A., 1965. *Res. vet. Sci., 6:* 433.

Lightfoot, R. J.; Marshall, T., 1975. *Proc. Aust. Soc. Rep. Biol., 7:* 36.

Lindsay, D. R., 1976. *Proc. Aust. Soc. Anim. Prod., 11:* 217.

Lindsay, J. R.; Purser, D. B.; Hogan, J. P., 1980. Unpublished proceedings of workshop *"The influence of nutrition on the fertility of male and female sheep in Australia and New Zealand."* Department of Agriculture, Perth. Report No. 12.

Lydiard, A., 1975. *N.Z. vet. J., 23:* 260.

Manns, E., 1972. *Res. vet. Sci., 13:* 140.

McManus, W. R.; Reid, J. T.; Donaldson, L. E., 1972. *J. agric. Sci., Camb., 79:* 1.

Rattray, P. V.; Jagusch K. T.; Smith, J. F.; Winn, G. W., 1980a. *Proc. N.Z. Soc. Anim. Prod., 40:* 34.

Rattray, P. V.; Jagusch, K. T.; Smith, J. F.; Winn, G. W.; MacLean, K. S., 1980b. *Proc. Ruakura Fmrs' Conf.,* p. 105.

Reeve, J. L.; Kenny, P. A.; Baxter, R.; Cumming, I. A., 1975. *Proc. Aust. Soc. Rep. Biol., 7:* 38.

Reid, R. L., 1958. *Aust. J. agric. Res., 9:* 788.

Reid, R. L., 1960. *Aust. J. agric. Res., 11:* 530.

Rizzoli, D. J.; Baxter, R.; Reeve, J.; Cumming, I. A., 1975. *Proc. Aust. Soc. Rep. Biol., 7:* 37.

Simonsen, E., 1971. In *Physiology of Work Capacity and Fatigue.* Charles C. Thomas, Publisher. Springfield, Illinois.

Thornton, R. F.; Hood, R. L.; Jones, P. N., Re, V. M., 1979. *Aust. J. agric. Res., 30:* 135.

Trenkle, A., 1974. *J. Anim. Sci., 38:* 1142.

Weston, R. H., 1966. *Aust. J. agric. Res., 17:* 933.