Current data on nutrient accretion of fattening bulls: Implications for the calculation of nutrient excretions

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Introduction

Implementing the Fertilizer Application Ordinance (DüV, 2017) and the Ordinance for Substance Flow Analysis (StoffBilV, 2017) in Germany requires a detailed calculation of livestock nitrogen (N) and phosphorus (P) excretions. Hence, the DLG (2014) published an instruction booklet on the balancing of nutrient excretions from farm animals. The booklet contains information on the N and P intake and the N and P accretion of fattening cattle. The difference between the intake and the accretion rate is used to calculate the N and P excretion per animal in different stages of the fattening period.

This project aimed to calculate the cattle nutrient excretions based on current N and P accretion data of Fleckvieh bulls. Data on nutrient excretions were compared to DLG data and the situation in a LfL trial.

Material and Methods

A feeding and serial slaughter trial was conducted at the Bavarian State Research Center for Agriculture (LfL). The trial included 72 Fleckvieh bulls with 120-780 kg live weight. Material and methods employed during the trial were previously described by Honig et al. (2020; 2022a; 2022b). Daily live weight gain (LWG) and empty body weight gain (EBWG) of bulls with different live weights were calculated based on growth performance data by Honig et al. (2020). The ratio of the two gain rates (LWG:EBWG) was determined from dividing the EBWG by the LWG. This ratio enables the accurate conversion of the N and P accretion per kg EBWG into the accretion per kg LWG. The resulting N and P accretion rates per kg LWG were used to calculate the total N and P accretion of bulls in specific live weight ranges. The weight ranges based on the DLG booklet and included the calf rearing (80-210 kg), and the fattening period (80-750 kg and 210-750 kg). Information on N and P intake and accretion (DLG, 2014 and own data) allowed to calculate the N and P excretion per animal in different live weight ranges.

Results and Discussion

The Fleckvieh bulls' daily LWG and EBWG are presented in Table 1. Bulls with 400 kg live weight show a peak in daily weight gain. The ratio of LWG:EBWG increases with increasing live weight and slightly decreases in the last weight group. This ratio can be used to convert nutrient accretion per kg of EBWG to nutrient accretion per kg of LWG. The evaluations

result in an average LWG:EBWG ratio of 0.95, which is in agreement with the ratio described by GfE (1995).

The N and P accretion rates per kg EBWG are based on empty body composition data by Honig et al. (2022a; 2022b). Accretion rates per kg LWG were calculated using the mean and exact LWG:EBWG ratio (Table 1). A reduced N and P accretion in the low live weight range can be explained by the lower LWG:EBWG ratio in young animals. At 300 kg live weight, the N and P accretion rates, calculated according to the mean and exact ratio, are congruent. In the higher live weight range, the accretion calculated according to the exact LWG:EBWG ratio is slightly higher than the values calculated using the mean ratio.

Tables 3 and 4 show N and P intake, accretion, and excretion rates of cattle in different live weight ranges. The tables combine and compare the DLG (2014) data with the N and P accretion calculated according to different LWG:EBWG ratios (Table 2). In addition, N and P intake, accretion, and excretion rates from growing bulls in a LfL trial are specified.

The N accretion calculated using the mean and exact LWG:EBWG ratio exceeds the accretion rates specified by the DLG in all live weight ranges. The exact calculated N accretion is higher than the accretion rates calculated by the mean LWG:EBWG ratio. Consequently, there are differences in the N excretion, which become particularly evident during the calf rearing period. The N excretion according to the exact LWG:EBWG ratio is six percentage points lower than specified by DLG (2014). The LfL trial also showed a lower N intake, which, in combination with a higher N accretion rate, led to lower N excretions in all stages of the fattening period. Similar to the N excretion, the combination of lower P intake with higher P accretion results in lower P excretion per animal.

The lower N and P intake in the LfL trial was induced by the bulls' higher daily weight gains (Table 1), which far exceeded the 1350 g/d used as a basis in the DLG booklet. The higher growth performance of Fleckvieh bulls in the LfL trial also results in a lower feed intake, as shown in Table 5. Furthermore, the energy, N, and P content in the LfL rations was higher than in the DLG's rations. Higher feed nutrient and energy levels can induce high growth performance. However, animal growth is also influenced by other factors such as genetics, management, and environment.

Conclusion

Balancing the nutrient excretions of fattening cattle provides a good basis for calculating the nutrient flow balance at animal and farm level. Current data on the N and P accretion of growing cattle allow the accretion rates to be calculated accurately in different live weight ranges. The nutrient accretion calculation on the basis of a LWG:EBWG ratio per weight group is only important for the calculation of the N accretion and can be omitted when calculating the P accretion. The mean N and P accretion per kg live weight gain is higher than indicated by the DLG and is particularly influenced by the higher nutrient accretion rates in young cattle. Our results show lower N and P excretion rates when combining an N and P intake according to DLG data with current N and P accretion rates in growing cattle. The LfL trial showed a consistently lower N and P intake in growing Fleckvieh bulls, which can be explained by the animals' higher growth performance.

Table 1: Fleckvieh bulls' daily live weight gain, empty body weight gain, and resulting live weight gain to empty body weight gain ratio.

Live weight (kg)	**Live weight gain (g/d)**	**Empty body weight gain (g/d)**	**Ratio LWG : EBWG**
100	1098	952	0.87
200	1554	1442	0.93
300	1784	1696	0.95
400	1870	1799	0.96
500	1850	1791	0.97
600	1727	1676	0.97
700	1469	1423	0.97
800	1007	962	0.95
Mean	1545	1468	0.95

Table 2: Nitrogen and phosphorus accretion rates per kg live weight gain, calculated using the mean LWG:EBWG ratio and the exact LWG:EBWG ratio per weight group.

Live weight (kg)	**Nitrogen accretion g/kg LWG**		**Phosphorus accretion g/kg LWG**	
	Mean ratio	Ratio per weight	Mean ratio	Ratio per weight
100	31.0	28.3	7.1	6.5
200	31.3	30.6	7.3	7.1
300	31.0	31.0	7.3	7.3
400	30.2	30.5	7.2	7.3
500	28.8	29.3	7.0	7.1
600	26.9	27.5	6.7	6.8
700	24.5	24.9	6.2	6.3
800	21.3	21.4	5.6	5.7
Means				
100-800 kg	28.1	28.0	6.8	6.8
80-210 kg	31.2	29.5	7.2	6.8
80-750 kg	29.1	28.9	7.0	6.9
210-750 kg	28.8	29.0	6.9	7.0

Table 3: Balancing of nitrogen excretions per animal and weight range, based on data by DLG (2014) and LfL.

Balancing of nitrogen excretions per animal	DLG	Intake DLG + mean accretion LfL	Intake DLG + exact accretion LfL	Intake LfL + exact accretion LfL
80-210 kg				
N intake (kg)	9.3	9.3	9.3	8.5
N accretion (kg)	3.5	3.7	3.8	3.8
N excretion (kg)	5.8	5.6	5.5	4.7
80-750 kg				
N intake (kg)	78.8	78.8	78.8	77.0
N accretion (kg)	18.1	18.8	19.4	19.4
N excretion (kg)	60.7	59.9	59.4	57.6
210-750 kg				
N intake (kg)	69.7	69.7	69.7	69.1
N accretion (kg)	14.6	15.2	15.7	15.7
N excretion (kg)	55.1	54.5	54.0	53.4

Table 4: Balancing of phosphorus excretions per animal and weight range, based on data by DLG (2014) and LfL.

Balancing of phosphorus excretions per animal	DLG	Intake DLG + mean accretion LfL	Intake DLG + exact accretion LfL	Intake LfL + exact accretion LfL
80-210 kg				
P intake (kg)	1.7	1.7	1.7	1.6
P accretion (kg)	0.9	0.9	0.9	0.9
P excretion (kg)	0.9	0.8	0.8	0.7
80-750 kg				
P intake (kg)	14.1	14.1	14.1	13.5
P accretion (kg)	4.4	4.6	4.6	4.6
P excretion (kg)	9.7	9.5	9.4	8.9
210-750 kg				
P intake (kg)	12.1	12.1	12.1	12.1
P accretion (kg)	3.5	3.7	3.8	3.8
P excretion (kg)	8.6	8.4	8.3	8.3

Table 5: Feed intake and feed energy and nutrient content in different stages of the fattening period, according to DLG (2014) and LfL.

Feed intake and feed energy and nutrient content	DLG	LfL
80-210 kg		
DM intake (kg)	360	354
Energy (MJ/kg DM)	11.1	12.0
N (g/kg DM)	25.9	24.0
P (g/kg DM)	4.8	4.5
80-750 kg		
DM intake (kg)	3720	3302
Energy (MJ/kg DM)	10.9	12.1
N (g/kg DM)	21.2	23.3
P (g/kg DM)	3.8	4.1
210-750 kg		
DM intake (kg)	3396	2974
Energy (MJ/kg DM)	10.9	12.1
N (g/kg DM)	20.5	23.2
P (g/kg DM)	3.6	4.1

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