

PERFORMANCE, CARCASS MERITS AND COMPOSITION OF SIMMENTAL CALVES AS AFFECTED BY THE FATTENING REGIME

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ABSTRACT

Twenty four Simmental calves, initially weighing 405.5 ± 18.7 kg and approximately 11 months old, were randomly assigned into two dietary groups, based on live weight, to study the effect of different fattening regimes on the animal performance, carcass merits and composition. The first group (n=12, F) was fed grass silage plus concentrate mixture which consisted of 97.1% sugar beet pulp and 2.9% minerals, fibers was the main source of energy. The second group (n=12, S), where starch was the main source of energy, was offered maize silage plus concentrate mixture that composed of 51% corn, 45% soybean and 4% minerals. Diets were fed *ad libitum* as a total mixed ration for 157 day. All diets consisted of 65% roughages (grass silage or maize silage) plus 35% concentrate mixture. Calves fed S diet significantly grew faster and reached higher final body weight (1485 g/d and 637 kg) in comparison with F diet (1261 g/d and 605 kg). Although both groups consumed almost the same amount of ration (average 9.2 kg DM/d) without significant differences, S group was more efficient for converting feed to gain compared to F group (6.07 vs. 7.39 kg DM/ kg gain). Hot carcass weight, dressing percentage and scores of carcass conformation and fatness were similar for both S and F groups. Only kidney fat weight was significantly higher for S (10.2 kg) than F group (7.74 kg). No significant differences were detected between S and F groups in the percentages of lean, fat, bone and lean: fat ratio of the whole carcass.

This study showed that although the fiber based-diet as a dietary energy source did not improve animal performance compared to the starch based-diet, but it produced similar carcass merits with the same content of lean, fat and bone. More researches are needed to study the energy pathways, partitioning and deposition in the different body tissues when fiber based-diets are used in beef production rations.

Keywords: Beef cattle, fattening, performance and carcass merits.

INTRODUCTION

Nowadays, meat producers are looking for untraditional methods for minimizing production costs and at the same time increasing quantity and quality of meat or at least maintain it at the same level compared with the traditional ones. During the postnatal life till slaughtering, animal performance and its carcass characteristics and composition are mainly affected by the genetic type, the feeding level and the diet composition. Because feed costs are the major proportion of total variable costs in most beef systems, research is now directed towards formulate new types of diets adapted to sustain a high meat production with lower costs of production. So efficiently managed forage feeding can be the cheapest feedstuff and become an important tool in reducing beef production costs as reported by French *et al.* (2001).

Several researches (Comerford *et al.*, 1992; Fluharty and Loerch, 1996; Fiems *et al.*, 1999; Hoving-Bolink *et al.*, 1999; Rossi and Loerch, 2001; De Campeneere *et al.*, 2002; Sami *et al.*, 2004; and Browne *et al.*, 2005) studied the effect of feeding maize silage plus concentrates that contain a high amount of starch as a fast and easy source of dietary energy in beef cattle fattening. But the continuous and high need of using starch as source of energy by human changed the researchers thinking to use fiber based-diet as source of energy to produce beef to save starch for human use and reduce the production costs, which are still under investigation.

Therefore, the objective of this experiment was to study the effect of different fattening regimes based on fibers compared to starch as source of dietary energy on the performance, carcass merits and carcass composition from lean, fat and bone of Simmental calves.

MATERIALS AND METHODS

Animals and diets

This experiment was carried out at the experimental farm station in Hirschau, Technical University of Munich, Freising-Weihenstephan, Germany. Twenty four Simmental calves, initially weighing 405.5 ± 18.7 kg and approximately 11 months old, were randomly assigned into two dietary groups, based on live weight. The first group (n=12, F) was fed grass silage plus concentrate mixture which consisted of 97.1% sugar beet pulp and 2.9% minerals, fiber was the main source of energy. The second group (n=12, S), where starch was the main source of energy, was offered maize silage plus concentrate mixture that composed of 51% corn, 45% soybean and 4% minerals. Diets were fed *ad libitum* as a total mixed ration for 157 day. All diets consisted of 65% roughages plus 35% concentrate mixture. Live body weights were recorded every 14 d throughout the feeding period. Average daily gain (g/d), feed efficiency (kg DM/kg gain) were calculated. Also, energy intake (ME, MJ/d) was estimated according Jeroch *et al.* (2000). Final live body weights were recorded at the end the experimental period.

Feeding system

Mixing roughages with concentrates of each group was carried out early in the morning by Marmix machine. Diets were individually fed by offering the diets every day at 8:00 O'clock after recording the residual of each animal to calculate its feed intake. The amount of the offered diets was changed every day according the feed consumption of each animal. Chemical analysis of the experimental diets was carried out according to A.O.A.C (2000) and fiber fractions were determined according to Goering and Van Sose (1970). Chemical composition and NDF and ADF contents of the F and S diets are presented in Table 1.

Table 1. Chemical composition (% in DM) of the fiber (F) and starch (S) based-diets.

Item	DM%	Ash%	EE%	CP%	CF%	NDF%	ADF%	Starch%
F	55.63	9.92	2.60	15.05	21.01	48.11	28.14	6.80
S	48.39	4.75	3.09	12.99	14.16	33.15	17.48	38.12

Carcass data collection

Calves were fasted 18 h before slaughter at a commercial packing plant. Hot carcass weight and kidney fat weight were obtained. Carcass conformation and fatness score were determined according to the EUROP beef carcass grading system immediately after slaughtering. Carcasses were chilled for 24 h at 4 °C. Best ribs (9-10 and 11) and flank cuts were removed from the left side of all carcasses and transferred under cooling (4 °C) to the institute of Animal Breeding, Bavarian State Institute for Agriculture, Grub (LfL), Germany. The two cuts were stored at 4 °C till the next day for dissection to lean, fat and bone tissues. Weights of these tissues were recorded to calculate their percentages in the cuts and in the whole carcass later on. Regression equations that adopted in cooperation with the institute of Animal Breeding in Grub (personal communication) for Simmental breed were formulated to estimate the percentage of lean, fat and bone content in the whole carcass as follows:

$$\text{Lean\%} = 62.3625 + 0.0022 * \text{half carcass weight} + 0.0065 * \text{kidney fat\%} + \text{fatness score} + \text{conformation score} - 0.1578 * \text{fat\% in best ribs} - 0.1512 * \text{fat\% in flank} - 0.2761 * \text{flank\%} + 0.2411 * \text{Dressing\%};$$

$$\text{Fat\%} = 0.688 + 0.00553 * \text{half carcass weight} + 0.2003 * \text{kidney fat\%} + \text{fatness class} + 0.2304 * \text{fat\% in best ribs} + 0.1587 * \text{fat\% in flank} + 0.6304 * \text{flank\%};$$

$$\text{Bone\%} = 35.0195 - 0.014 * \text{half carcass weight} + 0.0907 * \text{kidney fat \%} - 0.1275 * \text{fat\% in best ribs} - 0.0925 * \text{lean\% in best ribs} + 0.0316 * \text{bone plus sinew tissues\% in best ribs} + \text{conformation class} - 0.0704 * \text{Dressing\%} - 0.0432 * \text{fat\% in flank} - 0.0233 * \text{lean\% in flank} - 0.2689 * \text{flank\%}.$$

Statistical analysis

Collected data were statistically analysed according to the GLM procedure of SAS (1996) according to the following model:

$$Y_{ij} = \mu + G_i + E_{ij}$$

Where:

Y_{ij} = Observation

μ = Overall mean

G_i = Effect of the source of energy, $i = 1$ (fiber) and 2 (starch)

E_{ij} = Random error

Statistical differences between means were tested using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Animal performance

The chemical composition of the two experimental complete diets (Table 1) showed clearly that the F diet had higher crude fiber and less starch than the S based diet. This would allow conclusive comparison as planned. Initial body weight, final body weight, average daily gain, feed intake, feed

efficiency, energy intake and energy efficiency are presented in Table 2. Generally, feeding maize silage plus corn as a starch source of energy positively affected the performance of the fattening calves compared with feeding grass silage plus sugar beet pulp as a fiber source of energy. Calves fed S diet significantly ($P < 0.05$) grew faster and reached higher final body weight in comparison with F diet. Although both groups consumed almost the same amount of ration, kg DM/d without significant differences, however, S group was more efficient for converting feed to gain. The amount of kg dry matter needed for kg gain was significantly ($P < 0.05$) lower for S group compared to F group. Energy intake MJ/d for S group was found to be significantly ($P < 0.05$) higher than F group.

Table 2. Effects of fiber (F) and starch (S) based-diets on the performance of Simmental calves.

Item	F	S	± SE
n	12	12	
Initial wt., kg	407	404	5.51
Final wt., kg	605 ^b	637 ^a	9.39
Average daily gain, g/d	1261 ^b	1485 ^a	47.58
Feed intake, kg DM/d	9.32	9.01	0.14
Feed efficiency, kg DM/ kg gain	7.39 ^a	6.07 ^b	0.23
Energy intake, MJ/d	97.87 ^b	105.40 ^a	1.61

^{a,b} Means with different superscripts in the same row differ significantly ($p < 0.05$).

Present results showed that using starch as the main source of carbohydrate or dietary energy in the fattening diet in comparison to fiber had a significant positive effect on the feedlot performance parameters (average daily gain, final live body weight and feed efficiency). Fluharty and Loerch (1996) found that 68 Simmental x Angus crossbred calves fed corn silage-based diet had greater ADG and better feed efficiency than calves fed corn silage + alfalfa pellets + dry corn or dry corn + alfalfa pellets. High fiber diet decreased ADG by 13.8% compared to low fiber diet fed to Angus or Holstein steers (Tjardes *et al.*, 2002). This is close to the present results, where feeding F diet reduced the average daily gain by 12.9% compared to S diet. Also, high fiber diet fed *ad libitum* to the growing crossbred steers reduced their feed efficiency as illustrated by Schoonmaker *et al.* (2003).

High dietary energy content (11.7 MJ metabolizable energy/kg DM) and high dietary energy intake (105.4 MJ/day) of the starch based diet compared to the fiber based-diet (10.6 MJ metabolizable energy/kg DM and 97.9 MJ/day, respectively) at the present study could explain these results. Previous studies by Mandell *et al.* (1998); Sami *et al.* (2004); Browne *et al.* (2005) and Marino *et al.* (2006) showed that the energy level of the fattening diet is considered the major determinant of the animal performance. Comerford *et al.* (1992) indicated that corn silage, because of greater energy concentration, is more desirable forage in feedlot diets. More specifically, Fiems *et al.*, (1999) reported that daily live weight gain and feed efficiency clearly positively affected by the dietary amount of starch. But French *et al.* (2001) noticed that the high inputs of rapidly fermentable substrates, such as

soluble sugars or starch, can increase the concentrations of volatile fatty acids and lactate in the rumen, thereby causing a marked decrease in pH. This can reduce cellulolytic activity among rumen microbes, resulting in a lower rate of forage fiber digestion and thus increase the retention time in the rumen, which in turn can restrict feed intake. In addition, high starch diets usually increase the production costs and other sources of energy would be more accepted, provided that there are no adverse effects on the animal performance.

Carcass merits

Carcass merits are presented in Table 3. The results showed that hot carcass weight, dressing percentage and scores of carcass conformation and fatness were similar for both S and F groups. Only kidney fat weight was significantly ($P<0.05$) high for S group compared to F group.

Table 3. Effects of fiber (F) and starch (S) based-diets on the carcass merits of Simmental calves.

Item	F	S	+ SE
n	12	12	
Hot carcass wt., kg	336	357	7.3
Dressing, %	55.5	56.0	0.55
Kidney fat wt., kg	7.74 ^b	10.20 ^a	0.68
Carcass classification scores:			
Conformation*	3	4	0.17
Fatness**	2	3	0.14

^{a,b} Means with different superscripts in the same row differ significantly ($p<0.05$).

* The scale from 1-5 (1 = Poor, 2 = Fair, 3 = Good, 4 = Very good and 5 = Excellent).

** The scale from 1-5 (1 = Low, 2 = Slight, 3 = Average, 4 = High and 5 = Very high).

For any particular ration, an increase in intake will promote a higher growth rate and a fatter carcass. Fatness data showed that bulls received high energy diet had higher kidney fat weight, fatness and marbling scores (Sami *et al.*, 2004). This is in agreement with Mandell *et al.* (1998) who stated that higher energy diets increased carcass weights of Simmental steers after 249 d on fed. Hoving-Bolink *et al.* (1999) fed 210 crossbred Piemontese x Friesian heifers on either maize silage, grass silage or a mixture of the two. Their results showed that maize silage is the best diet, since it produced better daily weight gain, better carcass conformation than either the grass silage or the mixture produced. These findings do not agree with the present results that generally showed no significant effects were detected on the carcass merits due to the carbohydrate/energy source, except kidney fat weight that significantly increased by feeding starch based-diet. Other studies supported the present results such as Mandell *et al.* (1998) who reported that *Longissimus dorsi* areas and carcass traits of Simmental steers were not affected by dietary energy content. Also, Petit *et al.* (1994) found that feeding beef steers silage alone or supplemented with different levels of energy had no significant effects on the carcass data.

Carcass composition

Table 4 showed that there were no significant effects on the percentages of lean, fat, bone and lean:fat ratio in the whole carcass due to feeding either starch or fiber-based diets as energy source.

Table 4. Effects of fiber (F) and starch (S) based-diets on the whole carcass composition of Simmental calves.

Item	F	S	+ SE
n	12	12	
Lean %	71.15	71.03	0.44
Fat%	8.99	9.68	0.42
Bone%	19.86	19.29	0.15
Lean:fat ratio	7.9	7.3	0.14

Owens *et al.* (1995) mentioned that the protein:fat ratio of the carcass can be increased through increasing mature size, by administering hormones or hormonal modifiers, by limiting energy intake during the growing period or finishing period, or by slaughtering cattle at an earlier stage of maturity. Energetically, efficiency of accretion of fat is approximately 1.7 times that of protein. But because more water is stored with deposited protein than with deposited fat, lean tissue gain is four times as efficient as accretion of fat tissue. Conversion of protein to fat is very inefficient, suggesting that excess protein is utilized inefficiently. Although Fiems *et al.* (1999) reported that there is a possibility to manipulate carcass composition by shifting rumen fermentation towards more propionic acid when diets with a high concentration of degradable starch are used. Propionic acid increases insulin concentration in the blood. It is known that insulin levels are generally correlated with the degree of fatness of an animal, as well as different fat content in the carcass. Feeding starch based-diet (S group) to the fattening calves resulted in increasing average daily gain, final body weight, carcass weight, dressing percentage, kidney fat weight, and scores of carcass conformation and fatness compared to the fiber based-diet (F group), percentages of lean, fat bone and lean:fat ratio in the whole carcass were not significantly different between the two groups. The present results were supported by the findings of French *et al.*, (2001) and Greathead *et al.*, (2006) who found that the source of energy did not detectably affect carcass composition independent of rate gain.

CONCLUSION

This study showed that although fiber based-diet in the fattening ration did not improve animal performance compared to the starch based-diet, but it produced similar carcasses characteristics with the same percentages of lean, fat and bone. Economically, this in turn means that using fiber as a source of dietary energy as an untraditional method of meat production could produce the same quantity of meat as traditional ones with low costs. More investigations are needed to determine the exact energy pathways, tissue partitioning and deposition when fiber based-diets are used in beef production rations.

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تأثير نظام التسمين على اداء وخواص ومكونات ذبيحة عجول السيمنتال

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أجريت هذه الدراسة في محطة التجارب الزراعية بمعهد علوم الحيوان بجامعة موبنوخ التكنولوجية بالمانيا بغرض دراسة مدى تأثير أداء عجول السيمنتال وخواص الذبيحة ومكوناتها من لحم ودهن وعظم عند استعمال عليقة المصدر الاساسي للطاقة فيها هو الألياف وليس النشا كما هو معتاد. قسم ٢٤ عجلاً صر ١١ شهر ومتوسط وزن ابتدائي 405.0 ± 18.7 كجم عضويتا إلى مجموعتين على حسب وزن الجسم. المجموعة الأولى وعندها 12 غنيت على سبيل الحشائش بجانب مخلوط المركبات المكون من 97.1% لب بنجر السكر و 2.9% أملاح معدنية وكانت الألياف هنا هي المصدر الاساسي للطاقة. أما المجموعة الثانية وعندها 12 أيضاً والتي كان النشا فيها هو المصدر الرئيسي للطاقة فقد غنيت على سبيل الذرة ومخلوط مركبات مكون من 51% ذرة و 45% فول صويا و 4% أملاح معدنية. كانت التغذية حتى الشبع لمدة 157 يوم على عليقة مخلوطة كليا نسبة السيلاج (حشائش او ذرة) فيها 65% ومخلوط المركبات 35%.

نمت عجول المجموعة الثانية بمعدلات أسرع ووصلت لوزن نهائي أعلى (1485 جم/يوم و 637 كجم) مقارنة بالمجموعة الأولى (1211 جم/يوم و 605 كجم) وكانت الفرق بينهما معنوية. على الرغم من أن كلا المجموعتين استهلكتا نفس كمية المادة الجافة بمتوسط 9.2 كجم مادة جافة/يوما ولم تكن هناك أي فروق معنوية بينهما إلا أن المجموعة الثانية والتي كان النشا فيها هو المصدر الاساسي للطاقة كانت أكثر كفاءة غذائية وبصورة معنوية حيث احتاج 1 كجم نمو إلى 6.07 كجم مادة جافة مقارنة بالمجموعة الأولى حيث الألياف هي المصدر الاساسي للطاقة (7.39 كجم مادة جافة لكل كجم نمو).

لم تكن هناك أي تأثيرات معنوية على وزن الذبيحة الساخن و نسبة التصافي و تدرج الذبيحة من ناحية التكوين اللحمي وترسيب الدهن نتيجة اختلاف مصدر الطاقة بين المجموعتين. إلا أن المجموعة الثانية رسبت دهن حول الكليتين بكمية أكبر (1.02 كجم) مقارنة بالمجموعة الأولى (0.74 كجم) وكان الفرق بينهما معنوي. لم تكن هناك أي اختلافات معنوية بين المجموعتين في نسبة اللحم والدهن والعظم وكذلك نسبة اللحم إلى الدهن في كل الذبيحة.

ظهرت الدراسة أنه على الرغم من أن العليقة ذات المصدر الليفي للطاقة لم تحسن من أداء الحيوان مقارنة بالعليقة ذات المصدر النشوي للطاقة إلا أنها أعطت ذبائح مشابهة لها في معظم الخواص، كما أنها أنتجت نفس كمية اللحم. كما أظهرت الاحتياج إلى مزيد من الدراسات لمسارات تمثيل الطاقة وتوزيعها وترسيبها في صورة أنسجة الجسم المختلفة.