Partitioning of Energy into Muscle and Fat in Relation to Beef Composite Type and Age at Harvest

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ABSTRACT

Beef composite types have combined favourable traits of pure breeds. The energy requirement for Muscle (EM) and Fat (EF) deposition, the ratio of EF:EM and proportions of energy required to produce M and F were different ($P < 0.01$) for Beef composite types (CT) and harvest ages (HA). EF was dependent on both CT and HA due to interaction (P=0.03). The proportion of energy required to produce Fat (Prop F) increased from 60.2% at 274 d to 76.8% at 456 d (P<0.01) and the proportion of energy required to produce Muscle (Prop M) decreased from 39.8% at 274 d to 23.2% at 456d (P<0.01). Based on EF:EM ratio (3.0 or 75 % as a reference value) and energetic efficiency of producing M and F, M1, M2 and M3 can be harvested at 399d, M4 at 456d and TX can be harvested at or after 456 d to avoid the production of excessively fat carcasses.

INTRODUCTION

Understanding the partitioning of energy among tissues allows a more precise prediction of energy requirements, growth and functional characters of animals with respect to the genetic and environmental conditions (Tess et al. 1984). Energy partitioning pattern and retained energy can be used to determine optimum slaughter age of different biological types. The proportions of muscle, fat and bone significantly differ with age of the animal and the proportion of F increases as M decreases (Goonewardene et al. 2009). Hence, the ratio of energy used for fat to muscle deposition increases as animals age. The objective was to compare energy required to grow muscle and fat in the carcass tissues of five BeefBooster composites (M1, M2, M3, M4 and TX) serially slaughtered at six harvest ages from 274 to 456 d in two years and determine harvest times based on energetic efficiency.

MATERIALS AND METHODS

One hundred and seventy three crossbred steers from five BeefBooster composites (M1, M2, M3, M4 and TX) which were reared in two consecutive years were used to calculate energy values. The foundation breed of M1 was Angus (n= 32), M2 was Hereford (n= 34), M3 was small strains (n= 36), M4 was Limousin and Gelbvieh (n= 36) and TX was Charolais (n= 35). The animals were fed with a diet that contained 73.3% barley grain, 22.0% barley silage, 1.6% molasses and 3.1% feed supplement ad libitum twice a day over 183d. The fifteen steers were randomly selected and serially slaughtered on d1 (age = 274d), d71 (age= 347d), d99 (age= 372d), d127 (age= 399d), d155 (age=427d) and d183 (age= 456d) of the finishing period as three steers from each BeefBooster line. After both right and left sides were weighed, the left side of each carcass was separated into wholesale cuts and further divided into M, F and Bone. The empty body weight (EBW), empty body fat (EBF) and empty body protein (EBP) were estimated using procedures described by Basarab et al. (2003). The energy deposited as fat and muscle was calculated using the caloric value of fat and protein which are 9.385kcal/g and 5.539 kcal/g respectively (Brethour 2004) for each composite type and harvest age. The proportions of fat and muscle were calculated using total energy which was the summation of energy used to deposit F and M. The data were analysed using the GLM procedure of SAS and differences between CT and HA were determined. The significance was declared at P<0.05.

CONCLUSION

Animals deposit more fat with increasing age and more energy is partitioned to deposit fat. EF:EM ratio increased from 1.54 at 247d to 3.38 at 456d. The different composite types have different energy partitioning patterns. Based on EF:EM ratio (3.0 or 75 % as a reference value) and energetic efficiency of producing M and F, M1, M2 and M3 can be harvested at 399d, M4 at 456d and TX can be harvested at or after 456 d to avoid the production of excessively fat carcasses.

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Figure 1. Energy fat to energy muscle ratio for different composite types by harvest age

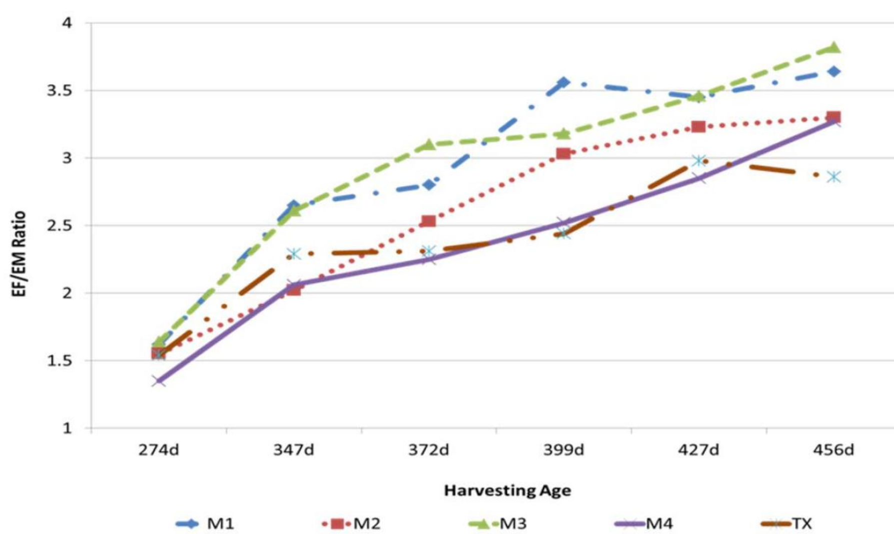

Figure 2. Proportion of energy used for fat and muscle deposition by harvest age for all composite types

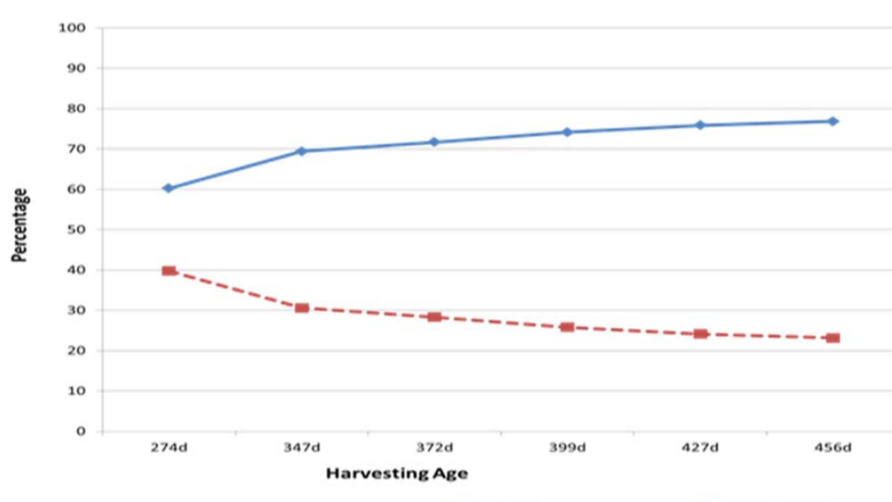

Table 1. Comparison of energy used to grow body tissues of composite types at different harvest ages

Strain	Harvest age (days)						P-Value
	274d	347d	372d	399d	427d	456d	
Energy fat/Energy total							
M1	61.7	72.3^{a}	72.9^{ab}	77.8^{a}	77.4^{a}	78.2^{a}	<0.01
M2	60.4	66.7^{b}	71.6^{ab}	75.1^{a}	76.2^{ab}	76.7^{a}	<0.01
M3	62.0	71.9^{a}	75.4^{b}	76.0^{a}	77.3^{a}	79.1^{a}	<0.01
M4	57.0	66.9^{b}	69.0^{a}	71.3^{b}	73.8^{b}	76.5^{ab}	<0.01
TX	60.1	69.1^{ab}	69.5^{a}	70.6^{b}	74.6^{b}	73.8^{b}	<0.01
Energy muscle/Energy total							
M1	38.3	27.6^{a}	27.1^{ab}	22.2^{a}	22.6^{a}	21.8^{a}	<0.01
M2	39.6	33.3^{b}	28.4^{ab}	24.9^{a}	23.8^{ab}	23.3^{a}	<0.01
M3	37.9	28.0^{a}	24.6^{b}	23.9^{a}	22.7^{a}	20.9^{a}	<0.01
M4	42.9	33.1^{b}	30.9^{a}	28.7^{b}	26.2^{b}	23.5^{ab}	<0.01
TX	39.9	30.9^{ab}	30.5^{a}	29.4^{b}	25.4^{b}	26.2^{b}	<0.01
Energy fat/Energy muscle ratio							
M1	1.6	2.6^{a}	2.8^{abc}	3.6^{a}	3.4^{a}	3.6^{abc}	<0.01
M2	1.5	2.0^{b}	2.5^{bd}	3.0^{b}	3.2^{ab}	3.3^{bd}	<0.01
M3	1.6	2.6^{a}	3.1^{c}	3.2^{ab}	3.4^{a}	3.8^{c}	<0.01
M4	1.3	2.1^{b}	2.2^{d}	2.5^{c}	2.8^{b}	3.3^{abd}	<0.01
TX	1.5	2.3^{ab}	2.3^{abd}	2.4^{c}	2.9^{ab}	2.8^{d}	<0.01

$^{a, b}$: Least square means with different letters within age are significant ($P<0.05$) and compare composite types. Letters are only shown when means are different ($P<0.05$).

Table 2. Average energy partitioned into fat and muscle, proportion of muscle and fat and energy fat to energy muscle ratio by harvest ages

Energy Component	Harvest age (days)						
	274	347	372	399	427	456	P-Value
Energy Fat (Mcal)	423.7^{a}	831.3^{b}	1058.8^{c}	1213.1^{d}	1394.3^{e}	1508.8^{f}	<0.01
Energy Muscle (Mcal)	275.1^{a}	362.3^{b}	412.8^{c}	416.4^{c}	441.6^{cd}	453.0^{d}	<0.01
Prop Fat^{x} (%)	60.2^{a}	69.4^{b}	71.7^{c}	74.2^{d}	75.9^{de}	76.8^{e}	<0.01
Prop Muscle^{x} (%)	39.8^{a}	30.6^{b}	28.3^{c}	25.8^{d}	24.1^{de}	23.2^{e}	<0.01
EF:EM	1.54^{a}	2.33^{b}	2.6^{c}	2.95^{d}	3.19^{e}	3.38^{e}	<0.01

$^{a, b}$: Least square means with different letters within trait are significant ($P<0.05$) and compare harvest ages.
^{x}:expressed as a percentage of tissues in regards to total energy.

What this research means to the beef industry:

Feeding cattle is expensive, especially with recent increases in feed and land costs. While consumers enjoy beef, being concerned most with its' quality attributes like flavour, tenderness and juiciness, the livestock producer must also be concerned with animal performance, costs of production, environmental sustainability and animal welfare. This research gets to the point of what is being produced (muscle vs. fat) at what stage in the animals' production phase (age) to determine if breed differences and age can be optimized in the feedlot to avoid producing excessively fat carcasses.