O185 *In vivo* 3D imaging to estimate the dynamic of body chemical composition along the growth of crossbred bulls

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Introduction

Assess the dynamics of body reserves is mandatory for improving efficiency and robustness of beef production systems. Nonetheless, the phenotyping of such physiological trait in living cattle remains challenging. The aim of present study was to evaluate the precision of the 3D imaging technology for the *in vivo* estimation of the chemical composition of crossbred bulls.

Material and Methods

All procedures performed on animals were approved by Ethics committee of Switzerland (n° 2020_03_FR). Forty-eight crossbred growing bulls (16 Brown Swiss dam × Angus sire, 16 Brown Swiss dam × Limousin sire, and 16 Brown Swiss dam × Simmental sire) were reared and slaughtered at the Agroscope experimental station from 25 up to 395 days old (BW, from 58 to 522 kg). Less than 2 hours before slaughter, body shape of bulls were recorded using a 3D imaging device (Le Cozler et al., 2019). Linear, circumferences, curves, surfaces and volumes body measurements were further determined from the corresponding 3D images (Metruxα®, 3D Ouest, Lannion, France). Half-carcass, blood and rest of empty body (EB, full body minus digesta, carcass and blood) were frozen (−20 °C), pending grinding, homogenization, mincing, and chemical analyses. Water (lyophilisation), lipid (ISO 6492:1999), protein (ISO 16634-1:2008) mineral (550 °C) and energy (ISO 9831:1998) contents were determined.
Partial least square regressions (R package "pls", v.3.6.3, R Core Team, 2020) with leave-one-out-cross-validation method were performed to estimate the body and carcass post mortem chemical composition from 3D morphological measurements, BW and sire breed (option "Scale" activated). The RMSE of prediction (RMSEP), R2 and the residual coefficient of variation (rCV; ratio of RMSEP to the mean of the dependent variate) are presented for each model selected.

Results and Discussion

Carcass were composed of 127 ± 57.0 (mean ± SD) kg of water, 36 ± 17.1 kg of protein, 23 ± 15.2 kg of lipid, and 8 ± 4.0 kg of mineral while EB was composed of 202 ± 87.8 kg of water, 57 ± 26.9 kg of protein, 41 ± 27.5 kg of lipid, and 11 ± 3.6 kg of mineral. Energy represented 1726 ± 968.6 MJ in carcass and 2921 ± 1649.3 MJ in EB. As expected, due to the large range of age and BW, the carcass and EB chemical composition range was wide, e.g. the lipid mass varied between 2 kg and 53 kg in carcass and between 3 kg and 96 kg in EB. Others chemical components were less variable than lipid.
Rear hindquarter 3D variables were the most frequent ones in the models. Partial volume (from shoulder to tail) was present in 9 on 10 models. Water and protein masses in carcass or EB were the components the most precisely determined by 3D imaging, with rCV between 3 and 5% (Table 1). The lipid mass was estimated with an RMSEP of 4 kg in carcass and 6 kg in EB. These errors were lower than RMSE of 7 kg in carcass and of 12 kg in EB reported by Fonseca et al. (2017) with body measurements variates in linear regression. However, rCV for lipid masses in Fonseca et al. (2017) were similar for EB (15% in both studies) but lower for carcass (15%) than in the present study (19%). Such discrepancy could be explained by heavier and fatter animals (crossbred Angus × Nellore bulls and steers) in Fonseca et al. (2017) than in the present study.

Conclusion and Implications

The 3D imaging is a novel, non-subjective, safe, and non-invasive method, which allows to assess finely and at high-throughput the body chemical composition of crossbred bulls along growth. New morphological phenotypes, e.g. abdominal volume and digestive content, from 3D imaging are ongoing. These developments will promote the effective use of 3D imaging for livestock precision farming.

Table 1
Partial least square regressions for estimating body chemical composition of crossbred bulls (n = 48) from 3D imaging, BW and sire breed.

	No. of latent variables[1]	R^2	RMSEP[2]	rCV[3] (%)
Carcass (kg)				
Water	4	99.23	5.8	4.6
Lipid	5	95.76	4.2	18.6
Protein	8	99.45	1.7	4.7
Mineral	5	98.62	0.6	7.6
Energy (MJ)	14	99.58	131	7.6
Empty body (kg)				
Water	8	99.66	6.6	3.3
Lipid	17	98.96	6.0	14.7
Protein	6	99.53	2.1	3.7
Mineral	13	99.67	0.7	6.2
Energy (MJ)	8	98.14	306	10.5

[1] Composed by 3D variables, BW and sire breed required to estimate the item based on the leave-one-out-cross-validation method.
[2] RMSEP, root mean square error of prediction.
[3] rCV, residual coefficient of variation.

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O186 Bioconversion of rice straw by *Tenebrio molitor*

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Introduction
Insects have recently been included in European regulations as possible ingredients for monogastric feed. Their ability to transform organic waste into biomass of high nutritional value makes them susceptible to being raised on the basis of circular economy criteria (Derler et al., 2021). Rice straw (RS) is a problematic by-product since their accumulation produce an important enviromental impact as their burning is prohibited (Viana et al., 2021). Thus, the aim of this work was to rear *Tenebrio molitor* larvae on diets with different proportion of rice straw looking its bioconversion into high-quality biomass for animal feed.

Material and Methods
One thousand four hundred larvae were reared from hatching to an average weight of 17.46 ± 2.73 mg on a substrate composed of oat flakes and brewer's yeast in an 80/20 ratio. Then, larvae were distributed into 4 treatments with 7 replicates each one. Basal diet (0RS) was formulated with breweŕs spent grain (10%) and bread by-products (86%), and three experimental diets where RS was included at 25% (25RS) and 50% (50RS), replacing bread by-products, and 96% (96RS). In addition, all diets included a mineral-vitamin premix at 4%. To the 7 replicates, 5 of them were assigned for performance-digestibility trial that lasted one month, and 2 additional replicates for acid uric determination as complementary assay to digestibility estimation (Van Broekhoven et al., 2015). When the experiment ended, larvae were separated from the feed and frass and slaughtered by freezing, lyophilized and analysed. The results were evaluated by ANOVA analysis and orthogonal contrast were also fitted to evaluate the lineal effect of RS level inclusion in diet on different parameter evaluated. Means were compared using Tukey's test, and differences were considered significant when $P < 0.05$.

Results and Discussion
As RS inclusion increased, larval weight gain and total intake were linearly decreased ($P < 0.001$), but no differences between 25RS and 50RS treatment for these parameters were observed. The feed conversion ratio of larvae fed on diet 96RS was the lowest ($P < 0.001$). This fact could be explained by the higher cannibalism in the replicates of 96RS treatment. In addition, a linear increase ($P = 0.05$) of mortality

Table 1
Effect of increased levels of rice straw (RS) in the diet on productive parameters and dry matter (DM) digestibility of *Tenebrio molitor* larvae.

Diets	0RS	25RS	50RS	96RS	SEM[1]	*P*-value
Productive parameters						
Larvae initial weight (mg)	54.87	54.87	53.78	54.23	0.302	0.291
Larvae final weight (mg)	124.33[a]	113.04[b]	106.53[c]	89.31[d]	0.690	<0.001[2]
Larvae gain weight (mg)	69.45[a]	58.16[b]	52.74[b]	35.08[c]	0.759	<0.001[2]
Larvae total intake (mg)	87.19[a]	59.99[b]	58.75[b]	17.98[c]	1.265	<0.001[2]
Feed conversion ratio (mg/mg)	1.37[a]	1.17[a]	1.26[a]	0.57[b]	0.029	<0.001[2]
Pupae (%)	10.00	12.40	12.00	9.00	0.889	0.682
Mortality (%)	4.00[b]	6.40[b]	8.80[b]	17.50[a]	2.197	0.050[2]
Coeff. Dry matter digestibility (%)	77.65[a]	63.70[b]	41.48[c]	45.27[c]	0.607	<0.001[2]
Insect composition (% DM)						
Dry matter (%)	34.62[a]	36.91[b]	33.42[c]	32.70[d]	0.032	<0.001[2]
Crude protein (% CP)	33.91[b]	29.67[c]	32.23[bc]	58.81[a]	0.231	<0.001[2]
Ether extract (% EE)	31.58[a]	20.60[b]	16.63[c]	11.05[d]	0.305	<0.001[2]

[a.] Means within in a row with different superscripts differ significantly ($P < 0.05$).
[1] SEM, standard error of the mean.
[2] Linear effect ($P < 0.05$).