Journal of Animal Science/vol.32, No.3; 2022/pp 123-129

Does the 9-11th rib composition correspond with body composition in fat-tailed Afshari lambs?

Hossein Shadman[1], Ehsan Mahjoubi[2*], Davoud Zahmatkesh[3], Mehdi Hossein Yazdi[4]

[1]MSC Graduated, Department of Animal Science, University of Znjan, Zanjan, Iran
[2]Assistant Professor, Department of Animal Science, University of Znjan, Zanjan, Iran
[3]Assistant Professor, Department of Animal Science, Arak University, Arak, Iran
[*]Corresponding author E-mail: e_mahjoubi@znu.ac.ir

Journal of Animal Science/vol.32 No.3/ 2022/pp 123-129
https://animalscience.tabrizu.ac.ir
OPEN ACCESS

DOI: 10.22034/AS.2022.42388.1592

Introduction: There are varieties of methods to predict lamb carcass composition (Stanford *et al*. 1998; Teixeira *et al*. 2006). However, in terms of repeatability, some of these methods were inconsistent and had high costs (Miller *et al*. 1988; Stanford *et al*. 1998). While it is time consuming and expensive, chemical analysis of the entire animal body produces the most satisfactory composition data. One of the most used methods in predicting carcass composition is one proposed by Hankins and Howe (1946). However, there are some inconsistencies with this method. Because fat-tail is a lipid-reach organ, it can markedly change the fat content of whole carcass and it appears that the equations of Hankins and Howe (1946) are not suitable for predicting the carcass chemical composition in fat-tailed sheep. Thus, the objective of this study was to evaluate the efficacy of Hankins and Howe (1946) equations in prediction of body composition in fat-tailed sheep.
Material and method: Lambs were cared for according to the guidelines of the Iranian Council on Animal Care (1995). At the end of a bigger experiment 10 lambs (6 males and 4 females; 43.9 ± 3.9; mean shrunk body weight; mean ± SD) were randomly selected and deprived from feed and water for ~18 h to obtain shrunk BW. The lambs were slaughtered according to Halal methods at an abattoir next to the University of Zanjan farm. After slaughter, the 9-11th rib sections were harvested from chilled carcasses for 24 h; fat, lean, fat-tail and bone were weighted separately and total separable fat (without fat-tail) and lean were grounded twice to obtain a homogenous sample for analyzing for DM, EE, CP, and ash according to AOAC (1999). The MEANS procedure of SAS (SAS 9.3, SAS Institute, Cary, NC) was used to calculate descriptive statistics of all independent and dependent variables. To model dependent variables of interest (separable lean, fat, and bone) as well as chemical composition (moisture, fat, protein, and ash) of carcasses, the REG procedure was carried out using predictive variables of physical and chemical composition of the 9-11th rib section. A significance of fixed effects was established at $P < 0.05$.
Results and discussion: Rib dissection separable lean, fat and bone percent were (mean ± SD) 33.9 ± 6.6, 23.6 ± 6.6, and 17.3 ± 7.4, respectively. In addition, rib dissection ether extract, crude protein, moisture, and ash percent were (mean ± SD) 27.6 ± 4.1, 19.3 ± 0.7, 49.6 ± 5.3, and 1.7 ± 0.3, respectively. Except for carcass separable bone percent (with and without fat-tail), it was shown that the 9-11th physical rib composition can properly predict the carcass separable fat (adjusted R^2 of 0.62 and 0.86 with and without accounting for fat-tail, respectively; $P < 0.01$) and lean (adjusted R^2 0.77 and 0.71 with and without accounting for fat-tail, respectively; $P < 0.01$). As for the carcass chemical composition, with or without accounting for fat-tail, none of rib chemical commotion based on *as-is* analysis predicted chemical carcass composition. However, when *as-is* data were represented as soft

tissue dry matter, only rib crude protein (%, without accounting for fat-tail) could predict carcass crude protein (adjusted $R^2 = 0.60$; $P < 0.005$). In general, our results for the first time in fat-tailed sheep, showed that the 9-11th rib section can only predict physical, but not chemical, composition of fat-tailed lamb carcass.

Key words: Carcass composition; Equation; Fat-tailed sheep; The 9-11th rib section

Introduction

Carcass assessment has a long history in the animal and meat science literature. There are varieties of methods to predict lamb carcass composition (Stanford *et al*. 1998; Teixeira *et al*. 2006). However, in terms of repeatability, some of these methods were inconsistent and had high costs (Miller *et al*. 1988; Stanford *et al*. 1998). While it is time consuming and expensive, chemical analysis of the entire animal body produces the most satisfactory composition data. One of the most used methods in predicting carcass composition is one proposed by Hankins and Howe (1946). However, there are some inconsistencies with this method; for example, McEvers *et al* (2018) concluded that equations developed by Hankins and Howe (1946) are not appropriate for estimation of carcass composition of calf-fed Holstein steers. Using the same method in Morada Nova ram lambs, Costa *et al* (2014) indicated that this method can satisfactorily estimate the crude protein (CP) and ether extract (EE) contents of the empty body, but more information must be generated to obtain more reliably applicable equations. Because fat-tail is a lipid-reach organ, it can markedly change the fat content of whole carcass and it appears that the equations of Hankins and Howe (1946) are not suitable for predicting the carcass chemical composition in fat-tailed sheep. Thus, the objective of this study was to evaluate the efficacy of Hankins and Howe (1946) equations in prediction of body composition in fat-tailed sheep.

Materials and Methods

Lambs were cared according to the guidelines of the Iranian Council on Animal Care (1995). At the end of a bigger experiment, 10 lambs (6 males and 4 females; 43.9 ± 3.9; mean shrunk body weight; mean ± SD) were randomly selected and deprived from feed and water for ~18 h to obtain shrunk BW. The lambs were slaughtered according to Halal methods at an abattoir next to the University of Zanjan farm. Then, the carcasses were chilled at 4°C for 24 h. Thereafter, the chilled carcasses were weighed again and cut lengthwise with a portable band saw. The 9-11th rib section was collected according to the described method by Hankins and Howe (1946). Briefly the section was removed by a keen knife immediately adjacent to the caudal edges of the 8th and 11th ribs; short plate was removed at roughly 15 cm from the most ventral portion of the *Longissimus thoracis et lumborum*. Then, whole section was weighted and divided to separable lean, separable fat, and separable bone to be weighted separately. Thereafter, the rest of half-carcass (without the fat-tail) was divided to separable lean, separable fat, and separable bone and each component was weighted. All aforementioned components for both half-carcass and the 9th and 11th ribs were mixed and were grounded twice and sub-samples were taken for analyzing for DM, EE, CP, and ash according to AOAC (1999). Fat-tail samples were taken separately for chemical analysis. Because of high fat content of fat-tail it was not grounded with half-carcass component and the final body chemical composition along with fat-tail was mathematically calculated based on the measured chemical composition. Moisture was calculated by drying samples at 80°C for 24 h. To have better comparison across the literature, data were presented based on either *as-is* and DM of soft tissue sample.

The MEANS procedure of SAS (SAS 9.3, SAS Institute, Cary, NC) was used to calculate descriptive statistics of all independent and dependent variables. To model dependent variables of interest (separable lean, fat, and bone) as well as chemical composition (moisture, fat, protein, and ash) of carcasses, the REG procedure was carried out using predictive variables of physical and chemical composition of the 9-11th rib section. A significance of fixed effects was established at $P < 0.05$.

Results and Discussion

Table 1 shows mean, standard deviation, and ranges for all variables used in model development. Because of high fat content of the fat-tail, when this part of body was added to calculations it caused CP and ash contents to be diluted.

Determination of the carcass composition is an important criterion in research and industry, but the whole carcass analysis is time consuming and costs money. In the current study, the moisture content of the 9-11th rib section was lower than what was observed by Costa *et al* (2014). In comparison with data published by Costa *et al* (2014) in Morada Nova sheep, rib section EE was similar, while CP and ash content were lower in the current study. Similar ranges were also reported for rib section by Hankins (1942) who had harvested different sheep breeds (Columbia, Corriedale, Shropshire, Southdale, Southdown, Hampshire x Corriedale, Hampshire x Eambouillet, South down x Corriedale, Corriedale x Southdown, Suffolk x Corriedale, and Tasmanian Merino). Furthermore, without accounting for fat-tail, EE and CP as well as ash content of Afshari lambs' carcasses in the current study were lower compared to Morada Nova sheep (Costa *et al*. 2014). However, when the fat-tail was

Table 1- Descriptive statistics of rib dissection and carcass samples in Afshari lambs

	Mean	SD	Minimum	Maximum
Number of carcasses	10	-	-	-
Rib dissection separable lean (%)	33.9	6.6	43.2	55.9
Rib dissection separable fat (%)	23.6	6.6	33.4	46.9
Rib dissection separable bone (%)	17.3	7.4	22.7	43.0
Rib dissection ether extract (%)	27.6	4.1	25.3	34.5
Rib dissection protein (%)	19.3	0.7	19.2	20.3
Rib dissection moisture (%)	49.6	5.3	45.6	57.6
Rib dissection ash (%)	1.7	0.3	1.6	2.4
Carcass separable lean (%)	54.3	5.5	43.0	62.4
Carcass separable lean + fat-tail (%)	44.9	5.0	34.6	51.9
Carcass separable fat (%)	19.8	3.8	15.9	27.3
Carcass separable fat + fat-tail (%)	41.1	6.5	29.9	51.5
Carcass separable bone (%)	19.2	2.9	12.5	24.2
Carcass separable bone + fat-tail (%)	15.9	2.8	9.8	20.3
Carcass ether extract (%)	18.7	4.0	14.7	26.2
Carcass protein (%)	18.3	1.7	15.7	21.2
Carcass ash (%)	3.4	1.2	2.4	5.6
Carcass moisture (%)	57.7	6.0	45.9	64.3
Carcass DM (%)	42.3	6.0	35.7	54.1
Fat-tail ether extract (%)	88.0	1.3	87.3	90.5
Fat-tail protein (%)	2.8	0.5	2.8	3.9
Fat-tail ash (%)	0.8	0.2	0.7	1.2
Fat-tail moisture (%)	6.7	2.6	5.3	10.5
Carcass + fat-tail ether extract (%)	30.6	3.9	30.6	37.0
Carcass + fat-tail protein (%)	15.7	1.6	14.4	18.1
Carcass + fat-tail ash (%)	2.9	0.9	3.0	4.7
Carcass + fat-tail moisture (%)	48.9	5.5	44.1	54.9
Carcass + fat-tail DM (%)	51.1	5.5	45.1	61.3

accounted for its composition in whole carcass, EE was greater and CP content was lower compared with other data (Costa *et al*. 2014). This discrepancy is partly because of the breed variation. Fozooni and Zamiri (2007) indicated very similar numbers in Iranian fat-tailed Ghezel and Mehraban lambs. Nevertheless, Fozooni and Zamiri (2007) reported ~24% EE, which is ~5% less than the current results, probably because they did not include fat-tail cut in their chemical analysis.

Prediction equations for the determination of carcass physical composition from the 9-11th rib section are presented in Table 2. Except for carcass separable bone, the R^2 values for carcass separable lean and fat were all high. The greatest R^2 value was observed for carcass separable fat without accounting for fat-tail part. For the first time in fat-tailed sheep, using the physical and chemical composition (based on *as-is* and DM) of the 9-11th rib sections, several models were developed to predict carcass composition (Table 2). Except for carcass separable bone, with R^2 values ≥ 0.50 for the current developed equations, the ability of the 9-11th rib section might be ideal to explain carcass physical composition of fat-tailed sheep. Without accounting for fat-tail, the intercept of the current equation developed for the prediction of carcass fat is lower concurrent with a reduced slope compared to that of the equation included in Hankins (1946) in sheep; when fat-tail comes to be accounted for, the intercept was greater while the slope was roughly similar. Greater intercept in the current study was probably because the high fat content of fat-tail and its effect to increase the whole carcass fat. As for separable lean without fat-tail, the developed equation is similar to that of Hankins (1946) based on the intercept and slope; however, equation of separable lean with fat-tail has lower intercept compared to what developed by Hankins (1946) with very close slope. While Hankins (1946) did not provide any R^2 for the developed equations, it appears that the 9-11th rib section physical composition was great to predict the whole body physical composition. Unfortunately, Costa *et al* (2014) did not develop any equation for predicting physical composition of carcass in Morada Nova sheep. McEvers *et al* (2014) showed that the original developed equations by the Hankins and Howe (1946) study are not suitable for predicting carcass physical composition of calf-fed Holstein steers.

Table 2- Prediction equations for the determination of carcass physical composition of Afshsri Lamb from rib 9-10-11 (%)

Item	Adjusted R^2	P value	Root MSE	Equation
Carcass separable lean (%)	0.71	0.0014	2.97	= 23.252 + 0.720 α
Carcass separable lean + fat-tail (%)	0.77	0.0005	2.39	= 15.797 + 0.674 α
Carcass separable fat (%)	0.86	0.0001	1.42	= 1.977 + 0.538 β
Total separable fat + fat-tail (%)	0.62	0.004	3.99	= 14.467 + 0.796 β
Carcass separable bone (%)	0.28	0.07	2.45	= 13.887 + 0.234 γ
Carcass separable bone + fat-tail (%)	0.21	0.10	2.46	= 11.286 + 0.203 γ

α = Rib dissection separable lean (%)
β = Rib dissection separable fat (%)
γ = Rib dissection separable bone (%)

Table 3 shows the prediction equations for the determination of carcass and carcass + fat-tail chemical composition from the 9-11th rib section based on *as-is* and DM analysis. In contrast to carcass physical composition equations, all chemical compositions (e.g. EE, CP or ash) had $R^2 \leq 0.5$. In addition, there was the same trend when those measurements were presented in a DM-basis equation, except for CP. Prediction of carcass CP (without accounting for fat-tail) was estimated using an equation with a R^2 of 0.60 [carcass CP = 10.712 + 0.854 rib protein (% of soft tissue sample DM); $P < 0.005$]. The developed equations to predict carcass chemical composition in the current study were based on *as-is* and DM analyses. Compared to Costa *et al* (2014), none of measured criteria (such as EE, CP and ash) with and without accounting for fat-tail did show adjusted R^2 values ≥ 0.5, indicating the ability of the 9-11th rib sections to predict carcass chemical composition may be less than ideal for fat-tailed sheep. Similar results were also reported for calf-fed Holstein steers by McEvers *et al* (2014) where they did not find any adjusted R^2 greater than 0.5. In contrast with the current results, Costa *et al* (2014) reported equations that show a very close relationship between EE, CP and ash content the 9-11th rib section with carcass chemical composition. This discrepancy might be because of the breed and genetic variations. In addition, Hankins (1946) also displayed that EE and CP, thogh ash, content of the edible meat was not very closely related to that of the carcass; however, the 4-12th rib section was used instead of 9-11th rib section in his study and there were no calculated R^2 for aforementioned measurements. For the first time in fat-tailed sheep, we showed that the rib section cannot properly predict the carcass chemical composition.

Table 3- Prediction equations for the determination of carcass and carcass + fat-tail chemical composition of Afshsri Lamb from rib 9-10-11 (as-is and DM basis)

Item	Adjusted R^2	*P*-value	Root MSE	Equation
Carcass (as-is)				
Moisture (%)	0.33	0.049	4.94	= 21.949 + 0.721α
Ether extract (%)	0.39	0.032	3.10	= 0.579 + 0.655β
CP (%)	-0.06	0.505	1.70	= 29.610 + (-0.583) γ
Ash (%)	-0.11	0.799	1.23	= 2.803 + 0.322 δ
Carcass + fat-tail (as-is)				
Moisture (%)	0.37	0.035	4.32	= 14.775 + 0.688 α
Ether extract (%)	0.41	0.026	2.99	= 12.254 + 0.665 β
CP (%)	-0.05	0.480	1.62	= 27.077 + (-0.589) γ
Ash (%)	-0.12	0.892	1.00	= 2.672 + 0.141 δ
Carcass (DM)				
Ether extract (%)	0.40	0.029	2.43	= -3.315 + 0.87 α*
CP (%)	0.60	0.005	2.37	= 10.712 + 0.854 β*
Ash (%)	-0.10	0.702	3.47	= 6.505 + 0.473 γ*
Carcass + fat-tail (DM)				
Ether extract (%)	0.47	0.017	1.91	= 9.828 + 0.782 α*
CP (%)	0.44	0.021	2.95	= 6.059 + 0.794 β*
Ash (%)	-0.11	0.743	2.79	= 5.741 + 0.326 γ*

α = Rib moisture, % of soft tissue sample
β = Rib ether extract, % of soft tissue sample
γ = Rib protein, % of soft tissue sample
δ = Rib ash, % of soft tissue sample
α* = Rib ether extract, % of soft tissue sample DM
β* = Rib protein, % of soft tissue sample DM
γ* = Rib ash, % of soft tissue sample DM

Carcass chemical composition was also evaluated in DM basis in the current study. Developed equations based on DM showed the similar trends as what was observed with *as-is* basis. However, when they were represented on a DM basis, rib section could predict carcass CP content (without accounting for fat-tail) with an adjusted R^2 of 0.60. Therefore, except for CP, the 9-11th rib section has no value to predict carcass EE and ash represented based on soft tissue DM.

Prediction of physical and chemical body composition of fat-tailed Afshari sheep was investigated in the current study. Except for carcass separable bone percent (with and without fat-tail), it was shown that the 9-11th physical rib composition can properly predict the carcass separable fat and lean. With or without accounting for fat-tail, none of rib chemical composition based on *as-is* analysis predicted chemical carcass composition. When it was presented based on soft tissue DM, only rib CP (%, without accounting for fat-tail) could predict carcass CP. Generally, our results for the first time showed that the 9-11th rib section is only suitable to predict physical, but not chemical, composition of fat-tailed lamb carcass.

Acknowledgements: The authors gratefully thank Hamid Amanlou and Mohammad Hossein Shahir for their scientific comments. Also, we appreciate A, Amanlou, D. Aliyari, S. M. Mousavi, E. Madainia, H. Moghaddam, and the staff of Experimental Farm in Zanjan University for their assistance in carrying out of this experiment.

Conflict of interest: None of the authors has a financial or personal relationship with other people or organizations that could inappropriately influence or bias the present paper.

References

AOAC, 1999. Association of Official Analytical Chemist. Official methods of analysis, AOAC 16th Edition. International, Gaithersburg, USA.

Costa MRGF, Pereira ES, Pinto APP, Silva Amde S, de Medeiros AN, Mizubuti IY, Ribeiro ELde A, Campos ACN, Gadelha CRF and Oliveira RL, 2014. Prediction of body chemical composition of Morada Nova ram lambs using the composition of ribs section between 9th and 11th. Semina: Ciências Agrárias 35: 2019-2031.

Fozooni R and Zamiri MJ, 2007. Relationships between chemical composition of meat from carcass cuts and the whole carcass in Iranian fattailed sheep as affected by breed and feeding level. Iranian Journal of Veterinary Research 8: 304-312.

Hankins OG, 1946. Estimation of the Composition of Lamb Carcasses and Cuts. Technical Bulletins, United states, Department of Agriculture, No. 944

Hankins OG and Howe PE, 1946. Estimation of the composition of beef carcasses and cuts. United States Department of Agriculture Technical Bulletin No. 926. U.S. Government Printing Office. Washington, DC.

Iranian Council of Animal Care, 1995. Guide to the Care and Use of Experimental Animals. Isfahan University of Technology. Isfahan, Iran.

McEvers TJ, May ND, Reed JA, Walter LJ, Hutcheson JP and Lawrence TE, 2018. Estimation of carcass composition using rib dissection of calf-fed Holstein steers supplemented zilpaterol hydrochloride. Journal of Animal Science 96: 1396–1404.

Miller MF, Cross HR, Baker JF, Eyers FM and Recio HA, 1988. Evaluation of Live and Carcass Techniques for Predicting Beef Carcass Composition. Meat Science 23: 111-129.

Stanford K, Jones SDM and Price MA, 1998. Methods of predicting lamb carcass composition: A review. Small Ruminant Research 29: 241-254.

Teixeira A, Matos S, Rodrigues S, Delfa R and Cadavez V, 2006. In vivo estimation of lamb carcass composition by real-time ultrasonography. Meat Science 74: 289-295.

DOI: 10.22034/AS.2022.42388.1592

آیا ترکیبات دنده ۹-۱۱ باترکیبات بدن دربره‌های دنبه‌دار افشاری مطابقت دارد؟

حسین شادمان[۱]، احسان محجوبی[۲]، داود زحمتکش[۲] و مهدی حسین یزدی[۳]

تاریخ دریافت : ۱۳۹۹/۸/۲۶ تاریخ پذیرش: ۱۴۰۰/۱۱/۲۰

۱ دانش آموخته کارشناسی ارشد گروه علوم دامی، دانشگاه زنجان، زنجان، ایران
۲ استادیار گروه علوم دامی، دانشگاه زنجان، زنجان، ایران
۳استادیار گروه علوم دامی، دانشگاه اراک، اراک، ایران
مسئول مکاتبه: Email: e_mahjoubi@znu.ac.ir

چکیده

زمینه مطالعاتی: ارزیابی ترکیبات لاشه در علوم دامی و گوشت قدمتی طولانی دارد. نشان داده شده است که ترکیب دنده ۹ تا ۱۲ با کل ترکیب بدن در گوسفند مرتبط است، ولی این ارتباط در گوسفندان دنبه دار بررسی نشده است. **هدف**: پیش بینی ترکیب بدنی گوسفندان دنبه دار در حال رشد با استفاده از ترکیب دنده ۹-۱۱ به عنوان پیش گویی از ترکیب کل بدن. **روش کار**: ۱۰راس بـــره به طور تصادفی (با میانگین وزن کشتار ۳/۹ ± ۴۳/۹) انتخاب شدند. پس از کشتار، بعد از ۲۴ ساعت بخش‌های دنده ۹-۱۰-۱۱ از لاشه‌های سرد جدا شدند. چربی، عضله، دنبه و استخوان به طور جداگانه وزن شده و کل چربی قابل جداسازی (بدون دنبه) و عضله، دو مرتبه برای بدست آوردن یک نمونه همگن برای آنالیز شیمیایی در آینده چرخ شدند. **نتایج**: درصد گوشت، چربی، و استخوان قابل جداسازی دنده (میانگین ± انحراف معیار) به ترتیب. عبارت بودند از: ٦/٦ ± ٣٣/٩، ٦/٦ ± ٢٣/٦، ٧/٤ ±١٧/٣. به علاوه، درصد عصاره اتری، پروتئین خام، رطوبت، و خاکستر دنده (میانگین ± انحراف معیار) به ترتیب عبارت بودند از: ٤/١ ± ٢٧/٦، ٠/٧ ± ١٩/٣، ٥/٣ ± ٤٩/٦، و ٠/٣ ± ١/٧. به جز درصد استخوان قابل جدا سازی لاشه (با و بدون احتساب دنبه)، نشان داده شـد که ترکیبات فیزیکی دنـــده ۹-۱۰-۱۱ می تواند به درستی چربی (R^2 تصحیح شده بیشتر از ۰/۶۲؛ $P < ۰/۰۱$) و عضله قابل جداسازی (R^2 تصحیح شده بیشتر از ۰/۷۱، با و بدون دنبه) را پیش بینی کند. در مورد ترکیب شیمیایی لاشه، با یا بدون احتساب دنبه، هیچ یک از ترکیبات شیمیایی دنده بر اساس as-is نمی‌تواند ترکیبات شیمیایی لاشه را پیش‌بینی کند. با این حال، هنگامی که داده‌ها بر اساس درصد as-is و درصد ماده خشک بافت نرم نشان داده می‌شوند، تنها درصد پروتئین خام دنده (بدون احتساب دنبه) می‌تواند پروتئین خـــام لاشـه را پیش‌بینی کند (R^2=۰/۶۰، $P < ۰/۰۰۵$). **نتیجه گیری نهایی**: به طور کلی، نتایج ما برای اولین بار در گوسـفندان دنبه‌دار نشـان داد که بخش دنده ۹-۱۱ فقط می‌تواند ترکیبات فیزیکی لاشـه بره‌های دنبه‌دار را پیش‌بینی کند و نمی‌تواند ترکیبات شیمیایی لاشه را پیش‌بینی کند.

واژگان کلیدی: ترکیبات لاشه، معادله، گوسفندان دنبه‌دار، دنده ۹-۱۰-۱۱