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in

Purroy A. (ed.).
Body condition of sheep and goats: Methodological aspects and applications

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 27

1995
pages 191-195

Environmental temperature: composition and conformation of the carcasses of pre-ruminant kid goats and lambs

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SUMMARY - In order to quantify the effect of environmental temperature on the composition and conformation of the carcasses of pre-ruminant kid goats and lambs, a series of trials have been performed using such animals housed at different temperatures (12, 24 and 30°C). These animals were fed *ad libitum* with a milk replacer, from birth until two months of age. Taking into account the different food intake rates and the differences in the utilization of the feed ingested in the different species as a function of temperature, no significant differences in growth rate were observed in the different species. The composition expressed as a function of the empty-body-weight and the carcass composition of kids was affected by temperature only to the extent that the final live weight reached by these animals was affected by temperature. In contrast, in the lambs, body composition was affected by temperature, independently of the live weight achieved. Finally, despite the comments already made, the kids kept at the lowest temperature had carcasses with a better conformation.

Key words: Kid goats, lambs, composition, conformation, environmental temperature.

***RESUME -** "Température de l'environnement : composition et conformation des carcasses de chevreaux et d'agneaux pré-ruminants". L'objectif de cet article est de quantifier l'effet de la température de l'environnement sur la composition et la conformation des carcasses chez des chevreaux et des agneaux pré-ruminants. Une série d'essais a été ménée avec des animaux appartenant à ces deux espèces et soumis à des températures de 12, 24 ou 30°C. Les animaux étaient nourris* ad libitum *avec le même lait de remplacement depuis la naissance jusqu'à l'âge de deux mois. En tenant compte des différents niveaux d'ingestion et d'utilisation de l'aliment ingéré dans les 2 espèces selon la température, les taux de croissance n'étaient pas différents. La composition du poids vif vide et de la carcasse était affectée, chez le chevreau, par la température seulement lorsqu' il y avait un effet de la température sur le poids vif final. Par contre, chez l'agneau, la composition corporelle etait affectée par la température indépendamment du poids vif final atteint. En définitive malgré ces effets, les carcasses des chevreaux soumis à la température la plus froide, avaient une meilleure conformation.*

***Mots-clés :** Chevreaux, agneaux, composition, conformation, température de l'environnement.*

Introduction

All homeothermic animals living outside their thermoneutral zones are subject to conditions in which they may feel cold or hot. Such animals react to these conditions by modifying both their food intake and the degree to which the food ingested is used for growth. According to this it is well known that body composition is affected by environmental temperature, increasing fat content with increase in environmental temperature (Fuller and Boyne, 1971; Verstegen *et al.*, 1973; Close and Mount, 1978; Close, 1980; Dauncey *et al.*, 1983). However, during growth and when the animals are fed *ad libitum*, the change in their body composition depends on their capacity to neutralize the temperature effect by means of one different food intake (Dauncey *et al.*, 1983). In order to analyze these adaptive processes in pre-ruminant kid goats and lambs, a series of feeding, balance and slaughter trials has been carried out using animals of both species, which were fed *ad libitum* and maintained from birth until two months of age at different environmental temperatures (12, 24 and 30°C). All animals were slaughtered at the end of the trials. Here, the results from the analyses of composition of Empty Body Weights (EBW), of composition and conformation of carcasses and tissue composition of leg cuts of the animals are presented together with results on their energy intakes and growth rates.

Material and methods

Twelve male kid goats of the Granadina breed and twelve male lambs of the Segureña breed were housed at different environmental temperature (12, 24 and 30°C) from birth until two months of age. Four animals of each species were assigned to each temperature. All of the animals were allowed *ad libitum* access to a milk replacer from 9 a.m. to 6 p.m. daily. During this period the feed was maintained at 39 ± 2°C and was adequately mixed by means of a device designed specially for this purpose (Ruiz *et al.*, 1990). By means of suitable balance trials, the metabolizable energy content of the milk replacer in question was determined for each animal and temperature. When the animals reached two months of age they were slaughtered and their empty body weights (live weight minus weight of intestinal contents) were determined, as were the carcass weights. The length (K) and width (G) of the carcasses were also measured. The length was measured as the linear distance between the points of insertion of the tail and the neck and the width was measured as the maximum rump width at the level of the trochanters.

By chemical analysis of the right half of the carcass as well as of the skin, blood and viscera, its composition was determined as a function of empty body weight (dry matter, protein and fat contents, g/kg EBW). Once the left half of the carcass had been jointed, the tissue composition (percentage of muscle, covering and intramuscular fat and bone) of the leg cut was determined. Dry matter content was determined by lyophilization, nitrogen was analysed by the Kjeldahl method in order to calculate the protein content and the fat content by extraction with chloroform/methanol (2/1). The relationships existing between the weight of the carcass and its length, as well as between the carcass length and width, were calculated as these were considered to be useful indices of conformation.

To analyze the parameters derived, they were submitted to a 2 x 3 factorial analysis of variance (2 classes of animal and 3 temperatures), which allowed the effects of the different factors to be determined. In addition, and independently for each type of animals, all results on chemical composition of the empty body weights, and of the carcass, as well as from the analysis of the tissue composition of the leg cut, were submitted to another analysis of variance. In this latter statistical analysis temperature was considered as the source of variation and the empty body weights of the animals as covariance factor.

Results and discussion

Table 1 shows the mean values and standard errors of the different parameters analyzed. The statistically significant differences ($P<0.05$) between the values for the parameters for each type of animal, as a function of temperature, are indicated in the table. As expected, the empty body weights and carcass weights of the lambs were higher than those of the kids. This difference can be put down to the different birth sizes of the two types of animal (2.46 ± 0.14 kg for kids and 3.56 ± 0.39 kg for lambs). The mean growth rate was higher for lambs than for kids, although, as a result of the relatively high energy intakes achieved by kids housed at 12°C, the mean energy intake of the kids was higher. There was no significant difference between the fat content, expressed as a function of the empty body weights, of kids and lambs. However, the fat content of the carcass was higher for lambs ($P<0.05$) because the values achieved by the lambs housed at the two higher temperatures. The results of the analysis of tissue composition performed on the leg cut, show that the amount of covering fat and total fat was higher ($P<0.05$) in the lambs than in the kids irrespective of the temperatures at which they were housed. In both species the amount of cover fat increased as the temperature increased. The amount of intermuscular fat, however, increased in lambs, and decreased in kids, as the temperature increased. The conformation of the carcass, as measured by the ratio of carcass weight and carcass length, was, in general, not significantly different in the two types of animal. However, the conformation of the carcass of kids housed at 24°C was significantly lower ($P<0.05$) than in lambs housed at the same temperature.

Table 1. Metabolizable energy intake (MEI), growth rate (GR), empty body weight (EBW) and carcass chemical composition, carcass conformation indices and leg cut tissue composition values, for kid goats and lambs housed at different environmental temperatures (x ± SD)

	Kid goats			Lambs		
	12 °C	24 °C	30 °C	12 °C	24 °C	30 °C
GR (g/day)	101.4 ± 12.9	105.1 ± 6.7	130.1 ± 12.2	140.6 ± 24.9	161.0 ± 16.9	144.3 ± 20.4
MEI (kJ/kg 0.75.day)	1055 ± 56^{a}	912 ± 7^{b}	910 ± 12^{b}	961 ± 42^{b}	888 ± 8^{b}	836 ± 20^{b}
EBW						
kg	7.96 ± 0.44^{a,b}	7.33 ± 0.22^{a}	8.77 ± 0.41^{b}	11.77 ± 0.98	10.80 ± 0.75	10.25 ± 2.01
DM[†] (g/kg)	387.7 ± 14.8	327.4 ± 5.6	331.2 ± 4.2	315.5 ± 13.9	323.1 ± 14.8	336.7 ± 24.8
P[††] (g/kg EBW)	187.7 ± 2.3^{a}	186.3 ± 1.4^{a,b}	176.4 ± 2.8^{b}	189.3 ± 6.0	176.0 ± 3.0	174.8 ± 0.7
Fat (g/kg EBW)	113.9 ± 4.9^{a}	110.0 ± 3.8^{a,b}	125.5 ± 3.5^{b}	87.8 ± 14.3^{a}	113.9 ± 13.1^{b}	131.1 ± 28.0^{b}
Carcass						
Weight (kg)	4.00 ± 0.22^{a,b}	3.76 ± 0.11^{a}	4.71 ± 0.22^{b}	6.45 ± 0.54	5.84 ± 0.41	4.52 ± 1.06
DM (g/kg)	348.3 ± 13.7	347.4 ± 6.6	350.7 ± 5.2	336.0 ± 15.9	348.3 ± 16.3	361.3 ± 25.0
P (g/kg)	185.3 ± 10.6	185.4 ± 2.3	184.5 ± 2.5	187.2 ± 6.0^{a}	170.9 ± 3.2^{b}	175.2 ± 7.0^{b}
Fat (g/kg)	121.3 ± 8.6^{a,b}	114.9 ± 3.2^{a}	127.3 ± 2.0^{b}	99.1 ± 11.6^{a}	131.4 ± 10.2^{b}	142.5 ± 27.7^{b}
Carcass conformation						
Weight (kg)/K[†††]	153.3 ± 10.4^{a}	96.8 ± 2.8^{b}	118.8 ± 3.8^{c}	144.1 ± 8.8	137.5 ± 9.3	132.6 ± 18.7
K/G[††††]	2.72 ± 0.36	3.34 ± 0.14	3.19 ± 0.10	3.32 ± 0.61	2.75 ± 0.04	2.79 ± 0.05
Leg cut						
Muscle (%)	60.7 ± 0.1^{a}	62.2 ± 0.9^{a,b}	62.9 ± 1.1^{b}	64.9 ± 0.7^{a}	61.8 ± 1.3^{a,b}	60.9 ± 1.5^{b}
Cover fat (%)	3.3 ± 0.8	4.1 ± 0.4	4.7 ± 0.3	3.9 ± 0.8^{a}	5.3 ± 0.8^{a,b}	6.5 ± 0.9^{b}
Intermuscular fat (%)	6.6 ± 1.0	5.8 ± 0.3	4.6 ± 0.2	4.7 ± 0.3^{a}	5.4 ± 0.7^{a,b}	6.7 ± 0.6^{b}
Total fat (%)	10.0 ± 1.5	9.9 ± 0.5	9.3 ± 0.4	8.6 ± 0.6^{a}	10.7 ± 1.3^{a,b}	13.1 ± 1.1^{b}
Bone (%)	23.6 ± 1.4	24.3 ± 0.5	22.9 ± 1.0	22.3 ± 0.5	23.6 ± 0.4	21.8 ± 1.5

[†]DM: Dry matter
[††]P: Protein
[†††]K: Carcass length
[††††]G: Carcass width
a,b,c: $P<0.05$, values with different letters within each species are different

Both species managed to increase their food intake under cold (12°C) conditions so that their growth rates were not significantly different from those of animals housed at higher temperatures, although kids housed at 30°C did show growth rates that were higher (P=0.09) than those achieved at the other temperatures. As far as body composition is concerned, temperature was seen to have a clear effect on the more valuable parameters of both empty body weight composition and carcass composition. Although in the kids, there were no significant difference between the amount of covering fat nor of intermuscular fat as a function of the housing temperatures, differences did exist, although these only reached a significance level of P=0.10.

In accordance with the results obtained as a function of temperature, and given the fact that in the pre-ruminant animal under a determined nutritional regime the body composition seems to be determined chiefly by the weight (Walker, 1986), the parameters of composition were analyzed independently for each type of animal. In this analysis the environmental temperature was taken to be the principal source of variation and the empty body weights of the animals as covariance factor. The effect of covariance factor was significant (P<0.05) for kids resulting that of environmental temperature no significant. On the contrary, for lambs the effect of covariance factor was not significant and that of environmental temperature was (P<0.05). The results of this analysis show clearly that in the kids the differences noted in the body composition were in large part due to the differences in weights of the animals. In the lambs, in contrast, the differences in body composition arose chiefly as a result of the temperature differences. For example, in the kids 85% of the total variance in the fat content was explained by the covariance factor and 9% was explained by the temperature. In the lambs the covariance factor explained 15% of that total variance and temperature explained 79%. These results allow us to conclude that differences in the environmental temperature to which kid goats fed *ad libitum* are exposed, in function of both the food intake capacity of the animals and their corresponding energy requirements, will give rise to some differences in the final mean weights that are achieved. The body composition of these animals was essentially determined by their empty body weights and varied in function of these weights both between and within the temperatures assayed. In contrast, the empty body weights at slaughter of lambs housed at different temperatures were not significantly different but their body composition differed according to the temperature at which they were maintained.

The effects of environmental temperature on body composition of animals fed *ad libitum* during growth, has been widely studied in the pig (Fuller and Boyne, 1971; Verstegen *et al.*, 1973; Close *et al.*, 1978; Close, 1980; Dauncey *et al.*, 1983). According to the results obtained here, it is possible to say that body composition of lambs was affected by environmental temperature in the way that this has been well established. Fat deposition increased with increase in environmental temperature. The fact that kids housed at different temperatures show changes in body composition only in function of the different live weights reached reflects the capacity of these animals for maintaining energy homeostasis, this being a characteristic of the metabolism of leaner type species or breeds (Miller, *et al.*, 1979). At the same time, the fact that their body composition depends more on body weight than on other factors such as environmental temperature does not seem to be due to their low voluntary food intake as suggested by Walker (1986) since, the results reported here show that the kids, especially those housed at the lowest temperature, had rates of food intake, superior to those of the lambs. In relation to the changes that cover fat show according to environmental temperature, the available information results something contradictory. Holmes (1971) obtained an increase in the cover fat with decrease in temperature, whereas Sorensen (1962) and Dauncey *et al.* (1983) obtained and increase of that with increase in temperature and, Holmes and Coey (1967) reported no significant differences.

Analyzing the first index of body conformation (carcass weight/carcass length), it can be seen that, despite what has been said about the effect of temperature on the body composition of kids, those kids housed at 12°C were able to develop carcasses with a better conformation. Other authors have reported the effects of low temperatures on the conformation of different animals, especially pigs (Mount, 1968; Dauncey *et al.*, 1983), although to date no reports have been published on the carcasses of the animals described in the present report.

Conclusion

The results obtained here have practical implications. While lambs of similar body weights housed at different temperatures show differences in their body composition, kids of similar body weights housed at different temperatures have similar body composition showing those housed under cold conditions, carcasses with a better conformation.

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