RESULTS OF THE STUDY ON PRINCIPLES OF BROWN ADIPOSE TISSUE DEPOSITS AND CHARACTERISTICS OF ITS FATTY ACIDS IN PASTURE SHEEP LAMBS

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ABSTRACT

Brown adipose tissue in newborn lambs accounts for 4.52% of total body weight, then during postpartum period it intensively decreases, reaching 1.5% after a week, and finally it is gradually adsorbed or replaced with white adipose tissue. Fatty acids composition of lamb brown adipose tissue includes 17 unsaturated fatty acids (53.23%) and 11 saturated ones (46.95%).

KEY WORDS: Brown fat, fatty acid

INTRODUCTION

Mongolian sheep has reproductive feature that they directly produce their offspring on the pasture during the spring season, when average air temperature is minimal and wind speed is maximal. Therefore, the body temperature of neonates, as well as keeping its homeostasis at the normal level requires thermal exchange and specific factor of thermal regulation, when the fetus shifts from constantly warm environment of maternal body to severely cool external environment.

Not only offspring of various mammals, but also human infants face the necessity of withstanding above mentioned natural challenges and during first moments of the neonatal period the body temperature drops (hypothermia) (S.John Martin, 2010) and then the body temperature becomes constant due to activation of specific mechanism of thermal regulation for a shorter period. Thus the essence of such stabilization of the body temperature for a shorter period is associated with that animal body heat production process is different from mature animals. A factor for ensuring essential and specific processes is brown fat (Brown fat tissue) in humans and other mammals. (B.Cannon, J.Nedergaard, 2003, J.C.Rauch, 1969, G.Purevdorj 2005, M.E.Symons 1991, S.Andrei 1991, G.Amgalanbaatar 2004, Alison Sharpe Avram, 2005)

In other words majority of chemical energy produced in BAT can be converted into thermal energy (B.Cannon, 2004, Cousin B., 1992, D.Enebish, 2003). Thus it is most important quality of BAT function and therefore this topic has been attracting greater interests in the field of both human health and veterinary sciences.

As informed by other researchers, percentage of unsaturated fatty acids is higher in total fatty acid compositions of brown adipose tissue in mammals.

For example, unsaturated fatty acids of BAT in human, marmot and karakul sheep lamb is 63.35%, 71.3% and 54.52% respectively (G.Purevdorj, 2005). It reveals the function of BAT more specific. It is also demonstrated that concentrations of triglycerides are lower, while concentrations of both unsaturated fatty acids and phospholipids are higher in BAT of the rat, as well as polyunsaturated fatty acids (linoleic acid) are greater among unsaturated fatty acids. (T.Ohno, 1990).

Our study aimed to investigate deposits of BAT, principles of its re-absorption, and physic-chemical characteristics of the fat in pastured sheep lamb.

MATERIALS AND METHODS

Brown adipose tissue deposits in both fetus and neonate were measured after the skin removal, and the weight was measured by calibrated electronic balance.

Fatty acids were separated and measured by using gas and liquid chromatographic equipment with ionic detector based on thermal action up to 180°C.

RESULTS

Our previous study demonstrated BAT was detected on such localizations as prescapular surface of thoracic region, subscapular deep thoracic region, flank, thoracic cavity, pericardium, abdominal cavity and renal regions.

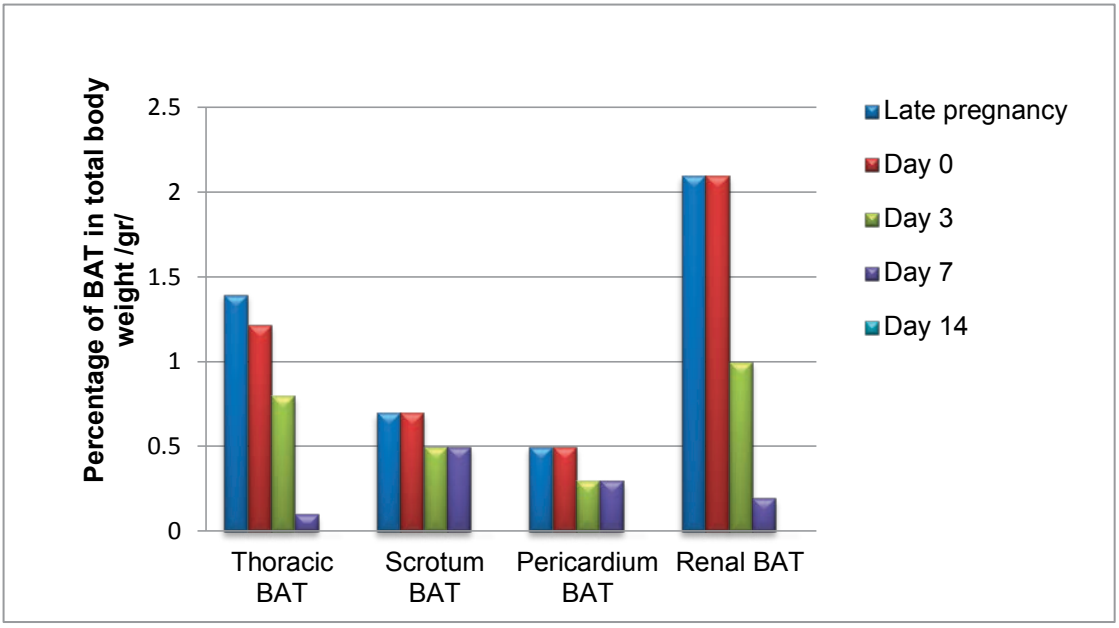
Mean percentages of above parts each in total body weight range from 0.5±0.45 to 2.1±0.05 during late pregnancy period and the highest deposit (2.1%) was found in perirenal part. Thoracic region BAT accounts for 1.4±0.05% during late pregnancy, and then the percentage dropped by 12.9% during parturition and by 42.86 to 92.86% during 3 to 7 days old age of newborn lamb, while renal brown fat dropped significantly by 52.38% in 3 day old lamb and 90.50% in 7 days old lambs ($p<0.05$). However, BAT deposits in the remaining parts such as scrotum and pericardium in 3 to 7 days old reduced by 30 to 40% as compared to that in neonatal lambs (Table 1). In such way, percentage of BAT in total body weight at 7 day old age intensively dropped as compared to those values during earlier period of the study.

Table 1

Percentage of BAT in total body weight

№	Ageing	Thoracic BAT	Scrotum BAT	Pericardium BAT	Renal BAT	Total
1	Late pregnancy	1,4±0,05	0,7±0,05	0,5±0,45	2,1±0,05	**4,7**
2	Day 0	1,22±0,05	0,7±0,05	0,5±0,45	2,1±0,05	**4,52**
3	Day 3	0,8±0,05	0,5±0,05	0,3±0,41	1,0±0,05	**2,6**
4	Day 7	0,1±0,05	0,5±0,041	0,3±0,39	0,2±0,03	**1,5**
5	Day 14	-	-	-	-	**0**

In the present study, a total of 11 saturated fatty acids and 14 unsaturated fatty acids were measured in lamb BAT, and of them, linoleic and linolenic acids as representatives of polyunsaturated acids with high biological activity, oleic acid from monounsaturated acids, and saturated fatty acids including palmitic and stearic acids were in highest concentrations. Especially, 66.7% of total amount of saturated fatty acids were palmitic acids, whereas heneicosanic acid was in the least concentrations. But, oleic acid accounts for 53.9% of total unsaturated acids, while docosadienoic acid for the minority.



Picture 1. Graph of percentages of BAT in total body weight.

Comparison of concentrations of both saturated and unsaturated fatty acids to those in superficial fat of Mongolian sheep demonstrated that total concentrations of unsaturated fatty acids in BAT of lambs are greater by 12.37% than those in superficial fat of Mongolian sheep. However, they were lower by 18.47% than those in marmot BAT (Table 2 and picture 2).

Table 2

Ratio of fatty acids in BAT of lamb and marmot and superficial fat of sheep

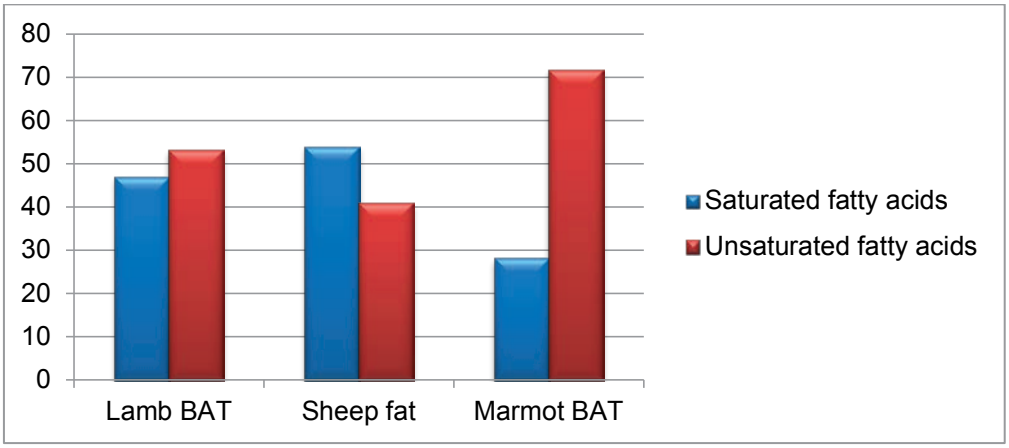
№	Types of fatty acids /%/	Lamb BAT	Sheep superficial fat /White adipose tissue/	Sheep renal fat *	Marmot BAT
1	Saturated fatty acids	46,95	54,05	67,2	28,23
2	Unsaturated fatty acids	53,28	40,91	29,1	71,75
3	Monounsaturated acids	34,7	37,43	25,8	-
4	Polyunsaturated acids	18,55	3,48	3,3	-

Table 3

Ratio of fatty acids in BAT of lamb

№	Saturated fatty acids	Measure/%/	№	Unsaturated fatty acids	Measure/%/
1	Capric acid	0,08	1	Myristoleic acid	0,07
2	undecynic acid	1,01	2	Pentadecanoic Acid	0,21
3	Lauric acid	0,96	3	Palmitoleic acid	5,00
4	Myristic acid	3,01	4	Heptadecanoic acid	0,61
5	Pentadecanoic Acid	0,50	5	Oleic acid	28,72
6	Palmitic acid	31,33	6	Erucic acid	0,09
7	Heptadecanoic acid	1,00	7	Linoleic acid	1,01
8	Stearic acid	8,34	8	Linoelaidic acid	0,07
9	Arachidic acid	0,34	9	Docosahexaenoic acid	0,0005
10	Other	0,37	10	γ Linolenic acid	9,00
			11	α-Linolenic acid	8,30
	-	-	12	Arachidonic acid	0,005
			13	Eicosapentaenoic acid	0,17
	Total	**46,95**		Total	**53,28**

Results of study on some chemical and physical properties of BAT show its freezing and melting points were -2.6^{0}C and 5^{0}C respectively. Values of acids, peroxides and saponifications were 0.58 mg KOH/kg, 0.1 mg KOH/kg and 188.7 mg KOH/kg respectively (Table 3). As well, contents of fat iodine and water soluble vitamin A with high biological activity are 80.2% and 2.4 mg respectively.



Picture 2. Ratio of fatty acids (percent)

Table 4

Results of study on chemical and physical properties of BAT in lamb

№	Parameters	Lamb BAT
1	Freezing point temperature	-2.6 °C
2	Melting point temperature	5 °C
3	Acid value	0.58 mg KOH/kg
4	Peroxide value	0.1 mg KOH/kg
5	Saponification value	188.7 mg KOH/kg
6	Iodine content	80.2 %
7	Vitamin A amount	1,4 mg

DISCUSSIONS

According to study performed by G.Purevdorj (2005), it was reported that small amount of BAT was in subscapular region of karakul breed sheep lamb and at day 14 after birth the structure disappeared due to growth of white adipose and connective tissues and it is in agreement with that renal BAT is easily turned into white adipose tissue (Y.Tanuma, 1975), as well as expression of UCP1 protein was active and USP1 antigen was detected, and then synthesis of this protein decreased at day 5 and UCP1 protein was undetectable (David Finn, 1993). Our study revealed that percentage of BAT in Mongolian lamb is relatively greater than other mammals and there were greatest deposits of BAT in perirenal and thoracic superficial and deep parts, and it is consistent with conclusions of other authors. It was observed that BAT deposits are highest at days 0 to 3 after the birth of Mongolian lamb, then it drops from day 5 of birth, and finally all brown adipose tissue turns into white adipose tissue, when lamb is 7 to 14 day old. It proved the conclusions of above authors.

Comparison of concentrations of both saturated and unsaturated fatty acids to those in Mongolian sheep superficial fat demonstrates total amount of unsaturated fatty acids in lamb BAT is greater by 12.37% than that in Mongolian sheep superficial fat and less by 18.47% than marmot BAT. However, it is similar to those in Karakul sheep lamb BAT. Amount of unsaturated fatty acids in fatty acid compositions of total BAT of pastured sheep lamb accounting for 53.23% is in agreement with those studied by other authors and it is consistent to main theoretical viewpoint of having high reactivity and oxidation capability of fatty acids in cells of BAT.

CONCLUSION

1. There is a principle that BAT deposits reaching 4.52% of total body weight of newly born lamb drops intensively with aging not exceeding 1.5% at day 7 and then it gradually absorbed or turned into white adipose tissue type.
2. Lamb BAT physical property is similar to that in WAT, but its fatty acid composition contains 14 unsaturated fatty acids (53.28%) and 11 saturated fatty acids (46.95%).

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