

EVALUATION OF DRESSING PERCENT AND QUANTITATIVE SKIN TRAITS IN NIGERIAN GOAT BREEDS

A. T. Yusuff^{1*} and T. R. Fayeye^{2*}

¹ College of Agriculture, Zuru, P.M. B. 1018, Zuru, Kebbi State, Nigeria

² Department of Animal Production, Faculty of Agriculture, University of Ilorin, P.M.B. 1515, Ilorin, Kwara state, Nigeria

* Corresponding author's e-mail: e-mail: folayusuff8@gmail.com

Abstract

Data collected on ninety-six male yearling West African Dwarf (WAD), Sokoto Red Goat (SRG) and their reciprocal crosses (i.e. WAD x SRG, SRG x WAD) were used to evaluate breed difference and heritability of dressing percent, pre-tanned skin weight, thickness and perimeter as well as the heritability of post-tanned skin weight, thickness and perimeter. WAD x SRG was significantly higher ($P < 0.05$) in dressing percent and pre-tanned skin weight than purebred SRG and WAD goats. It was also significantly superior ($P < 0.05$) to WAD in post-tanned skin weight, thickness and perimeter. Purebred SRG produced skins which were significantly superior ($P < 0.05$) in pre- and post-tanned thickness than the remaining genotypes. Heritability estimates for quantitative skin traits ranged from low to high, depending on the trait under consideration, genotype and the method of computation. Dam component heritability were generally higher for pre-tanned skin thickness and perimeter while the sire component heritability was higher for dressing percent, pre-tanned skin weight and post-tanned skin perimeter. The present study suggests that a crossbreeding programme involving WAD as sire and SRG as dam lines could help to improve meat dress out and increase the production of high quality skins for the leather industry.

Keywords: Crossbreeding, Heritability, Sokoto Red Goat and West African Dwarf Goat.

Introduction

In Nigeria, goats are kept not only for meat, the skin is also valuable (Attah, *et al.*, 2004). Goat Skins are very valuable by-products used mainly for leather manufacture. The Non-tanned goat skin is used for parchment, drumheads and sounding boards musical instruments. The tanned skins are exported from West African countries to industries in America and Europe. Sokoto Red goat is usually deep red in colour and it's about 60 cm long with mean male and female weights of 27 and 25kg, respectively. Skins obtained from Sokoto Red goats are of exceptional quality and are known as "Morocco" in the tannery trade (Wilson, 1991). West African Dwarf goat refers to a numerous meat breed found on the coast of West and Central Africa, they vary in colour and are trypanotolerant (Mason, 1996). Heritability is the fraction of observed phenotypic variance which results from differences in heredity among the genes and gene combination of individual genotype. Information on heritability of production traits is an essential aid to the prediction of selection response and the design of efficient breeding programmes (Els, 1999; Kosum, *et al.* 2012). Heritability estimates for goat breeds are common for growth traits (Els, 1999) and milk traits (Delfino *et al.*, 2011; Garcial-Peniche *et al.*, 2012). Only limited reports are available on

heritability estimate for quantitative skin traits in sheep (Gregory, 1982a). According to Gregory (1982a) and Slee *et al.* (1991) skin thickness is a heritable trait in farm animals with heritability estimate ranging between 0.25 and 0.60. However, such estimates are non-existent for dressing percent and quantitative skin traits in goats. Specifically, there is no previous information regarding heritability of dressing percent and skin traits in West African Dwarf and Red Sokoto Goats. The present work is therefore aimed at evaluating the heritability of dressing percent and quantitative skin traits in yearling West African Dwarf and Sokoto Red Goats and their reciprocal crossbred progenies.

Materials and Methods

Experimental site

Four genotypes of goats (i.e. West African Dwarf and Sokoto Red goats and their reciprocal crossbreds) were used for the study. The animals were raised at the College of Agriculture, Zuru, Kebbi state. Zuru is a South – East border town of Kebbi state. Zuru Local Government lies between latitude 11°35'N and 11°55'N and longitude 4°45' to 5° 25'E. The animals were managed in conformity with guidelines on the care and use of animals for scientific research.

Procedures for data collection

A total of ninety-six (96) pedigreed male yearling goats (i.e. 24 per genotype) were used to estimate genotypic difference and heritability of dressing percent, pre- and post-tanning skin weight, thickness and perimeter in West African Dwarf (WAD), Sokoto Red Goats (SRG) and their reciprocal crosses (i.e. WAD x WAD, SRG x SRG, WAD x SRG, SRG x WAD).

The selected bucks were weighed, slaughtered, flayed and eviscerated. Weights of animals before slaughtering and the eviscerated weights were taken to calculate the carcass dressing percentage as follows:

$$\text{Dressing Percentage (DP)} = (\text{Carcass weight} / \text{Liveweight}) \times 100$$

Fresh skins from slaughtered bucks were measured for weight, perimeter and thickness before tanning. Tanning was done using traditional tanning procedure as indicated by Yami and Merkel (2008). Tanned skins were then measured for thickness, weight and perimeter. Skin traits were measured as follows:

Skin Thickness: This was taken as the average value of thickness measurements (in millimetre). The measurements were taken at different regions of the skin (tail, neck, left and right fore-limbs, left and right hind limbs and also the middle of the skin) using micrometer screw gauge.

Skin perimeter: This was done by using a string to carefully trace the entire edges of each skin; the string was then placed on a tape rule to determine the perimeter in centimetre.

Skin weight: Skin weight was measured in gramme using a top loading weighing scale.

Statistical analysis

Data obtained for dressing percent and quantitative skin traits (pre and post-tanned skin weight, thickness and perimeter) were subjected to Nested design Model of ANOVA to obtain variance components due to sire, dam and progenies [11]. Estimates of heritability of dressing percent, pre-tanned skin weight, thickness and perimeter as well as the heritability of post-tanned skin weight, thickness and perimeter were calculated from sire, dam and combined sire-dam variance components using following formula (Becker, 1993):

$$\text{Heritability due to sire component: } h^2_b = 4\sigma^2_s / \sigma^2_p$$

$$\text{Heritability due to dam components: } h^2_d = 4\sigma^2_d / \sigma^2_p$$

$$\text{Heritability due to sire and dam components: } h^2_{s+d} = 2(\sigma^2_s + \sigma^2_d) / \sigma^2_p$$

Where σ^2_s = variance components due to sire (buck) effect.

σ^2_d = variance components due to dam (doe) effect

σ^2_p = total phenotypic variance obtained from $\sigma^2_s + \sigma^2_d + \sigma^2_e$, where σ^2_e is variance components due to random error.

The mathematical model used for the estimation of heritability is as follows:

$$y_{ijk} = \mu + \alpha_i + \beta_{ij} + e_{ijk}$$

Where: y_{ijk} = weight of the k th kid produced by j th doe that was mated by the i th buck, μ = mean weight, α_i = fixed effect of the i th buck, β_{ij} = fixed effect of the j th dam mated by the i th buck, e_{ijk} = uncontrollable environmental and individual genetic deviations.

Results

Results of dressing percent and pre-tanned skin weight, thickness and perimeter are presented in Table 1. Crossbred WAD x SRG produced carcass that was significantly higher ($P < 0.05$) in dressing percent than purebred SRG and WAD goats. Skin produced by SRG was significantly superior ($P < 0.05$) to the remaining three genotypes in pre-tanned thickness.

Table 1: Dressing percent, and pre-tanned skin weight, thickness and perimeter in WAD, SRG and their reciprocal crossbreds

	Genotype	Mean $\pm$ SD	COV	Minimum	Maximum
Dressing %	SRGxSRG	46.50 $\pm$ 1.46 ^d	3.13	43.00	48.90
	WADxWAD	51.23 $\pm$ 1.94 ^b	3.79	47.00	55.50
	WADxSRG	55.42 $\pm$ 1.45 ^a	2.62	52.60	58.00
	SRGxWAD	53.70 $\pm$ 2.21 ^b	4.13	48.00	57.00
Skin Thickness	SRGxSRG	1.53 $\pm$ 0.82 ^a	5.30	1.42	1.66
	WADxWAD	1.23 $\pm$ 0.04 ^d	3.53	1.15	1.32
	WADxSRG	1.48 $\pm$ 0.02 ^b	1.64	1.40	1.51
	SRGxWAD	1.44 $\pm$ 0.34 ^c	2.37	1.39	1.51
Skin Perimeter	SRGxSRG	399.67 $\pm$ 12.96 ^a	3.24	380.00	429.00
	WADxWAD	351.29 $\pm$ 33.23 ^b	9.46	313.00	419.00
	WADxSRG	400.67 $\pm$ 11.28 ^a	2.81	378.00	421.00
	SRGxWAD	397.04 $\pm$ 10.47 ^a	2.64	379.00	435.00
Skin Weight	SRG x SRG	1095.80 $\pm$ 59.70 ^b	5.45	1000.00	1180.00
	WADxWAD	947.50 $\pm$ 133.90 ^c	14.14	700.00	1150.00
	WADxSRG	1159.00 $\pm$ 62.60 ^a	5.40	1000.00	1260.00
	SRGxWAD	1145.40 $\pm$ 45.30 ^a	3.95	1030.00	1210.00

^{a, c, d} Means for the same trait carrying different superscripts are significantly different ($P < 0.05$). WAD, SRG represent West African Dwarf and Sokoto Red Goat, respectively.

WAD goat produced the thinnest pre-tanned skin. Pre-tanned skins from crossbred WAD x SRG and SRG x WAD were intermediate in thickness when compared with the two purebreds. The crossbred

WAD x SRG was significantly better ($P < 0.05$) than the two purebred in pre-tanned skin weight. Pre-tanned skin from purebred WAD was significantly lower ($P < 0.05$) in weight and

perimeter compared with the remaining three genotypes.

Results of post-tanned skin weight, thickness and perimeter among the four genotypes are presented in Table 2. The thickness of post-tanned skin produced by SRG was significantly superior ($P<0.05$) to the thickness of skins produced by each of the remaining three genotypes. WAD goat produced the thinnest skin after tanning. Tanned skin obtained from crossbred WAD x SRG and SRG x WAD were intermediate

in thickness between the two purebreds (1.29mm and 1.30mm for WAD x SRG and SRG x WAD, respectively). Crossbreeding helped to improve both post-tanned skin weight and perimeter. The crossbred WAD x SRG was also better than the two purebred in post-tanned skin weight. The two crossbred were not significantly different ($P>0.05$) in post-tanned skin weight and perimeter but were significantly superior ($P<0.05$) to purebred WAD in the two traits.

Table 2: Genotypic differences in post-tanned skin weight, thickness and perimeter in WAD, SRG and their reciprocal crossbreds

	Genotype	Mean±SD	COV	Minimum	Maximum
Skin Thickness	SRGxSRG	1.37 ±0.02 ^a	1.00	1.35	1.39
	WADxWAD	1.20±0.04 ^c	3.67	1.11	1.30
	WADxSRG	1.29±0.04 ^b	2.82	1.22	1.35
	SRGxWAD	1.30± 0.06 ^b	4.64	1.18	1.39
Skin Perimeter	SRGxSRG	397.08±21.18 ^a	5.33	370.00	472.00
	WADxWAD	341.25±35.77 ^b	10.48	273.00	413.00
	WADxSRG	391.08± 10.85 ^a	2.77	375.00	408.00
	SRGxWAD	387.21±9.85 ^a	2.54	365.00	415.00
Skin Weight	SRG x SRG	1025.00±61.60 ^a	6.01	900.00	1120.00
	WADxWAD	864.20±135.60 ^b	15.69	600.00	1100.00
	WADxSRG	1068.80±72.90 ^a	6.82	950.00	1240.00
	SRGxWAD	1057.10±64.00 ^a	6.05	950.00	1180.00

^{a,c} Means for the same traits carrying different superscripts are significantly different ($P<0.05$). WAD, SRG represents West African Dwarf and Sokoto Red Goat, respectively.

Estimates of heritability for dressing percent, and pre-tanned skin weight, thickness and perimeter are presented in Table 3. Heritability estimates for dressing percent ranged from medium to high depending on the genotype. Estimates obtained from sire variance component were generally higher than those obtained from dam component, except in purebred WAD. Sire, dam and combined components

heritability estimates for pre-tanned skin thickness ranged from low to medium and were generally lower compared with estimates for dressing percent. Estimates for pre-tanned skin thickness obtained from dam variance component were generally higher than that calculated from sire or combined sire and dam variance components, except in crossbred SRG x WAD.

Table 3: Heritability of dressing percent, and pre-tanned skin weight, thickness and perimeter among Nigerian goats

	Genotype	Sire	Dam	Sire+Dam
Dressing %	SRGxSRG	57.84	32.48	45.16
	WADxWAD	24.20	59.64	41.92
	WADxSRG	77.40	46.44	51.92
	SRGxWAD	62.36	66.06	64.20
Skin Thickness	SRGxSRG	0.34	0.43	0.39
	WADxWAD	0.20	0.52	0.36
	WADxSRG	0.46	0.57	0.52
	SRGxWAD	0.57	0.40	0.48
Skin Perimeter	SRGxSRG	0.04	0.99	0.52
	WADxWAD	0.60	0.76	0.68
	WADxSRG	0.43	0.52	0.47
	SRGxWAD	0.28	0.21	0.24
Skin Weight	SRG x SRG	0.16	0.12	0.14
	WADxWAD	0.82	0.80	0.81
	WADxSRG	0.36	0.49	0.42
	SRGxWAD	0.78	0.61	0.70

WAD, SRG represents West African Dwarf and Sokoto Red Goat, respectively.

Estimates of heritability for pre-tanned skin perimeter obtained from dam and combined variance components were generally higher than estimates

obtained from sire component, except in crossbred SRG x WAD. Generally, Sire, dam and combined component heritability estimates for pre-tanned skin

weight ranged from medium to high, except in purebred SRG. Estimates of heritability for pre-tanned skin weight from sire component were higher than estimates obtained from dam and combined variance components, except in WAD x SRG.

Table 4: Heritability of post-tanned skin weight, thickness and perimeter among WAD, SRG and their reciprocal crossbreds

	Genotype	Sire	Dam	Sire+Dam
Skin Thickness	SRGxSRG	0.10	0.58	0.34
	WADxWAD	0.82	0.75	0.78
	WADxSRG	0.20	0.19	0.19
	SRGxWAD	0.21	0.28	0.25
Skin Perimeter	SRGxSRG	0.47	0.05	0.26
	WADxWAD	0.02	0.81	0.51
	WADxSRG	0.73	0.32	0.53
	SRGxWAD	0.53	0.11	0.32
Skin Weight	SRG x SRG	0.05	0.07	0.06
	WADxWAD	0.91	0.28	0.59
	WADxSRG	0.37	0.37	0.37
	SRGxWAD	0.26	0.26	0.26

WAD, SRG represents West African Dwarf and Sokoto Red Goat, respectively.

Heritability estimates for post-tanned skin thickness calculated from dam variance component were generally higher than those obtained from sire and combined sire and dam components, except in purebred WAD. Generally, heritability estimates for post-tanned skin perimeter and weight ranged from low to high (0.05-0.81 and 0.05-0.91 for skin perimeter and weight, respectively). Estimates for post-tanned skin perimeter obtained from dam and combined variance components were generally lower than estimates calculated from sire component, except in purebred WAD.

Discussion

The dressing percents obtained in the present study was within the range of 38-57 percent reported by Attah *et al.* (2004) for adult WAD and SRG. According to McKenzie-Jakes (2007), dressing percentage of meat goats ranges between 40-55% depending on the breed and condition of the animal. A collation of research results from different sources by Wilson (1991) showed a dressing percentage of 44.7-50.0 for Bornu White goats slaughtered at 20.5-25.0 kg live weight and 43.7-48.1 for Sokoto Red goat slaughtered at 19.8-24.2 kg live weight. The same report by Wilson (1991) showed that young male goat castrates could have a dressing percentage as high as 54-55%. The higher dressing percents observed for crossbred goats in this study suggest a potential for increased carcass yield through crossbreeding. Recently, Osung, *et al.* (2011) suggested the need to upgrade the indigenous stock of WAD goats for increased productivity. The increased carcass yield of crossbred goats observed in this study may be exploited for improved efficiency of goat meat production in Nigeria. The skin weight for both purebred and crossbred WAD and SRG

Heritability of post-tanned skin weight, thickness and perimeter among the four genetic groups is presented in Table 4. Heritability estimates for post-tanned skin weight, thickness and perimeter were generally lower than those obtained for pre-tanned skin thickness except in the purebred WAD.

goats in the present study were similar to that reported by Okello *et al.* (1994) for Mubende goat in Uganda. Wilson (1991) reported a mean dry skin weight of about 420 g and useful tanning area of 0.28-0.65 m² for Sokoto Red goats. The observed genotypic difference in skin perimeter in the present study is consistent with recent findings by Salehi *et al.* (2013) in their evaluation of two goat types (hairy and cashmere) for skin and leather production. The difference among goat genotypes for skin thickness in this study was in agreement with the results of Williams and Thornberry (1992) and Murray (1996) who obtained significant differences in skin thickness among bloodlines of Merino sheep. The superiority of the crossbred above WAD goats in skin weight, thickness and perimeter suggest that crossbreeding could be used to promote these quantitative skin parameters. Apart from genotypic differences, the age at which the animals are slaughtered may also cause a slight change in the dressing percent of goats. A report by Khatum, *et al.* (2013) showed that landless and marginal farmers sell their animals at younger age with a concomitant slight reduction in dressing percentage compared with commercial farmers. The heritability estimates for pre-tanned and post tanned skin thickness in the present study were generally higher than estimates in earlier reports for different species (Hynd, *et al.*, 1996; Juo *et al.*, 2004; Zerehdaran *et al.*, 2004). For instance, Hynd, *et al.* (1996) reported a heritability of 0.17 for skin thickness in merino sheep. In other studies, Juo *et al.* (2004) observed a heritability of 0.36 for skin fold thickness in man, while Zerehdaran *et al.* (2004) reported an heritability estimate of 0.28 for skin weight in broilers chicken. The lower heritability estimates for post-tanned skin traits compared with

estimates for pre-tanned skin traits suggest that there are low correlations between genotype and post-tanned skin traits. It may therefore be more difficult to evaluate animals directly or rely on selection alone for improving the post-tanned skin traits. It may further be inferred that other factors such as processing effect are important on measurements of post-tanned skin traits. The higher heritability obtained for pre-tanned skin thickness in the crossbred goats suggest that crossbreeding prior to selection may enhance progress in improving the pre-tanned skin thickness of West Africa dwarf goats. There is the need for further study to determine the reason behind the high post-tanned heritability of skin thickness in the WAD goats.

Conclusion

This study suggests that Sokoto Red goat had the best pre- and post-tanned skin thickness. However, a crossbreeding programme involving WAD as sire and SRG as dam lines could help to improve meat dress out and increase the quantity of high quality skins for the leather industry. The precision of the heritability from small population sample size as used in this study could be enhanced by using prediction models that combines available small population records with genotypic data.

Acknowledgment

The authors wish to thank the Management of College of Agriculture, Zuru, Kebbi State, for providing the facilities for rearing the goats used for this study.

References

- Attah, S., Okubanjo, A. O., Omojola, A.B. and Omosehinwa, A. O. K. (2004). Body and carcass linear measurements of goats slaughtered at different weight. *Livestock Research for Rural Development* 16 (8) 2004. <http://www.lrrd.org/lrrd16/8/atta16062.htm>
- Becker W. A. (1993). *Manual of Quantitative Genetics* (5th Ed.). Academic Enterprises Vallman, Washinton, USA 189pp
- Delfino. R. P., Selvaggi, M., Celano, G. V. and Dario, C. (2011). Heritability estimates of lactation traits in Maltese goat. *World Academy of Science, Engineering and Technology*, 5(6):602-604, 2011. <http://www.waset.org/publication/2749>.
- Els, J. F. (1999). Heritability estimates for growth traits in the improved Boer goat. http://www.nbri.org/na/old/agricola_files/Agricol_a1998_99_No10_09_Els.PDF
- Garcial-Peniche, T. B., Montaldo, H. H., Valencia-Posadas, M., Wiggans, G. R., Hubbard, S. M., Torres-Vasquez, J. A. and Shepard, L. (2012). Breed differences over time and heritability estimates for production and reproduction traits of dairy goats in the United States. *Journal of Dairy Science* Vol. 95 No 5, 2012, pp 2707 – 2717. <http://www.ncbi.nlm.nih.gov/pubmed/22541500>
- Gregory, I. P. (1982a) Genetic studies of South Australian Merino Sheep III: Heritabilities of various wool and body traits. *Australian Journal of Agricultural Research*, 33: 355- 362.
- Hynd, P. I., Ponzoni, R. W., Grimson R., Jaensch, K. S., Smith, D. and Kenyon, R. (1996). *Wool Technology and sheep breeding*. 44: 3, (1996) pp167 – 177. <http://www.aaft.com.au/woolskin.pdf>
- Juo, S. H., Lin, H. F., Rundek, T., Sabala, E. E., Boden-Albala, B., Park, N., Lan, M. Y., and Sacco, R. L. (2004). Genetics and environmental contributions to carotid intima-media thickness and obesity phenotypes in the Northern Mahattan family study. *Stroke* 35(10),(2004) pp2243-2247. <http://www.ncbi.nlm.nih.gov/pubmed/15331789>
- Khatum, M. A., Amin, M. R., Alam, M. R. and Khan, M. S. I. (2013). Effect of market age on production of goat meat and skin. *Bangladesh Journal of Animal Science*, 42 (1), (2013) pp 67-70. <http://banglajol.info/index.php/BJAS/article/view/15785>
- Kosum, N., Taskin, T., Abas, Y. and Kaymakci, M. (2004). Heritability Estimates of Birth and Weaning Weights in Saanem, Bornova and Saanem x Killis Goat. *Pakistan Journal of Biological Science* 7(11): 1963-1966, 2004.
- Mason. I. L. (1996). *A world Dictionary of Livestock Breed, Types and Varieties*. C.A.B International, 1996 Ed. 273 pp
- McKenzie-Jakes, A. (2007). Getting Started in the Meat Goat Business: Selecting and Evaluating Goats for Meat Production Bulletin I (2007) 26pp. http://www.famu.edu/cesta/main/assets/File/coop_extension/small
- Minitab (2003). VARCOM, procedure of MINITAB . *Minitab statistical software for windows, version 14, September (2003)*. Minitab Inc. USA. www.minitab.com
- Murray, P. J. (1996). Effect of nutrition on skin thickness of fine and broad wool Merino sheep. *Proceedings in the 21st Australian Society of Animal Production biennial conference, Brisbane, Australia,1996* pp 388.
- Okello, K. L., Ebong, C. and Opuda- Asibo, J. (1994). Effect of feed supplements on weight gain and carcass characteristics of intact male Mubende goat fed elephant grass. *Proceeding of the third biennial conference of the African Small ruminant Research Network UICC Kampala Uganda 5-9th December 1994*. ILRI. Nairobi Kenya. pp183-183. <http://www.fao.org/wairdocs/ilri/x5473b/x5473b00.htm#Contents>
- Osung, P. O, Nsa, E. E.,Egbegbulem, V. N. and Ubua, J. A. (2011). Potentials of small ruminant production in Cross River rain forest zone of Nigeria. *Continental Journal of Anim. Vet. Res.* 3, 1 (2011) pp 33 – 37.

- www.wiloludjournal.com/ojs/index.php/cjvetres/article/download/
- Salehi, M., Kadim, I., Mahgoub, O., Nehgadari, Sh and Eshraghi-Naeni, R. S. (2013). Effect of type, sex and age on goat skin and leather characteristics. *Animal Production Science*-
<http://doi.org/10.1071/AN13032>.
- Slee, J., Alexander, G., Bradley, L. R., Jackson, N. and Steven, D. (1991). Genetic aspect of cold resistant and related characters in new born Merino lambs. *Australian Journal of Experimental Agriculture*, 31:2 (1991) pp 175-182.
- Williams, A. J. and Thornberry, K. J. (1992). The skin thickness of medium wool Merino sheep and its relationship to wool production. *Proceedings of the 19th Australian Society biennial conference, Melbourne, Australia, 1992* pp138-141.
- Wilson, R. T. (1991). Small ruminant production and the small ruminant genetic resources in tropical Africa. *FAO Animal Production and Health Paper*. Vol. 88, 1991.
<http://dagris.ilri.cgiar.org/bibdetail.asp?RC1081>
- Yami, A. and Merkel, R. C. (2008). Sheep and Goat Production Handbook for Ethiopia (ESGPIP, Ethiopia).
<http://www.esgpip.org/handbook/Chapter10.html>. Pg 275 92208)
- Zerehdaran, S., Vereijken, A. L., Van Arendonk, J. A. and Van der Waaijt, E. H. (2004). Estimation of genetic parameters for fat deposition and carcass traits in broilers. *Poult. Sci.* 83, (2004)pp521-525.
<http://www.ncbi.nlm.nih.gov/pubmed/15109049>

(Received 01 July, 2014; Accepted 29 July, 2014)