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RELATIONSHIPS BETWEEN HAEMOGLOBIN (Hb) TYPE AND PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF RAHMANI EWES AND LAMBS

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ORIGINAL ARTICLE

ABSTRACT: *Two hundred Rahmani ewes and seventy-one lambs used to study the relationship between the type of haemoglobin and some productive and reproductive traits. Distribution of Hb types and allelic frequencies were higher for type AA of ewes, while for lamb's type BB was higher than type AA. Fertility rate was higher in ewes with the type of haemoglobin AA than ewes with type AB or BB. Hemoglobin type, year of mating and breed of sire were not significant effects on fertility, while, age of dam and season of mating had a significant (P<0.01 or P<0.05) effect on fertility. Autumn season was the best season in fertility (84%) compared to (60%) in summer and (64%) in winter season. Ewes sired by Rahmani rams had the highest fertility (73%) compared to those sired by Chios rams (66%). All factors (Haemoglobin type, age of dam, year of lambing, season of mating, and breed of sire) had no significant effect on litter size at birth. However, ewes with Hb BB produced more lambs than either ewes with HB AB or ewes with Hb AA. Also, ewes aged 4 years had the highest litter size at birth. Ewes mating during autumn season produced more lambs than those mating during summer. Haemoglobin type was not significant effect on body weights of Rahmani lambs and F1 cross ½ C ½ R at all ages studied. Rahmani lambs with Hb AA had the lowest value of birth weight (4.05 kg vs. 4.14; 4.3 kg) compared lambs with Hb AB or BB, while lambs with Hb BB had highest weight at weaning , 6, 9 and 12 months of ages. F1 (½ C ½ R) lambs with Hb AA had the highest weight at birth, 6, 9 and 12 months of age, while lambs with Hb BB had the highest weight at weaning age. Haemoglobin type was not significant effect on daily gain at all periods studied for both Rahmani and F1 (½ C ½ R) lambs. Generally, Rahmani and (½ C ½ R) lambs with Hb AB had the lowest value of daily gain at all periods studied than lambs with Hb AA or Hb BB.*

Key words: *haemoglobin type, Rahmani ewes, reproductive performance*

INTRODUCTION

Haemoglobin (Hb) are group of proteins whose chief functions are to transport oxygen from the lungs to the tissues and carbon dioxide in the reverse direction, they are composed of polypeptide chains called globin and iron protoporphyrin heme groups. In the normal sheep, two types of Haemoglobin (Hb A and Hb B) can be found and these are controlled by two autosomal co-dominant genes, designated Hb A and Hb B, three phenotypes therefore are recognizable (AA, AB and BB) and can be readily identified. Harris and warren (1955) first demonstrated the existence of variable Haemoglobin (Hb) types in sheep, also. Evans and Turner (1965) designated the two (Hb) alleles as A and B, by electophoretic studies the fast-moving fraction is designated as A and the slow-moving fraction as B, thus, the three electrophoretic phenotypes are AA, AB and BB. Huisman et al. (1958) reported that Hb AA had higher Oxygen affinity than Hb BB since that time much interest has been shown in the relationship of Hb type to production and health-related traits. Such research and the frequencies of Hb alleles in various breeds have been reviewed by Agar et al. (1972). Gene frequency of polymorphic phenotypes seems to be related to performance of small ruminants. According to Agar et al. (1972) reported that the distribution of Haemoglobin variants is related to geographic environments (Wang et al. 1991), Also Vanderhelm et al. (1958) studying the Haemoglobin of different geniuses of animals it was found that abnormal Haemoglobins which are genetically controlled, may be present the results of a study of two different abnormal Haemoglobins in the sheep are given. It was found that these two Haemoglobin types show a genetical pattern, which is similar to that of some abnormal Hb in human beings. The objective of this study was to evaluate the relationship between haemoglobin types of the ewes or lambs and some productive and reproductive traits.

MATERIALS AND METHODS

The present study was carried out at the experimental farm of Animal Production Department, Faculty of Agriculture, Al-Azhar University, Assiut, Egypt.

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Haemoglobin types

In February of 2004, a blood samples were collected from the jugular vein in heparinised tubes using (10 ml) glass tubes from 71 lambs (41 Rahmani and 30 ½ C ½ R) from first and second lambing season. Also, a 200 blood samples were collected from Rahmani ewes. Then blood samples were transported under ice–cold conditions to the laboratory (Zoology Department Faculty of Science, Assiut University) without loss of much time. A small sample of Haemolystes were prepared from each blood samples and applied to Titan III Cellulose Acetate plate. The haemoglobin types (Hb) in the samples are separated by electrophoresis using alkaline buffer (pH 8.2–8.6) and are stained with ponceau's Stain. The evaluations of the haemoglobin bands were determined by Gel– Pro Analyzer 3.1 (Program in computer) according to the procedure mentioned in Helena Laboratories publications (1985).

Haemoglobin types were determined by the location of the band or bands. Figure 1 shows an electrophoretic separation bands using alkaline buffer and are stained with Ponceau-S stain and evaluations by Gel–Pro Analyzer 3.1. Haemoglobin A has the fastest electrophoretic mobility followed in decreasing mobility by Hb-AB and HB-BB, respectively.

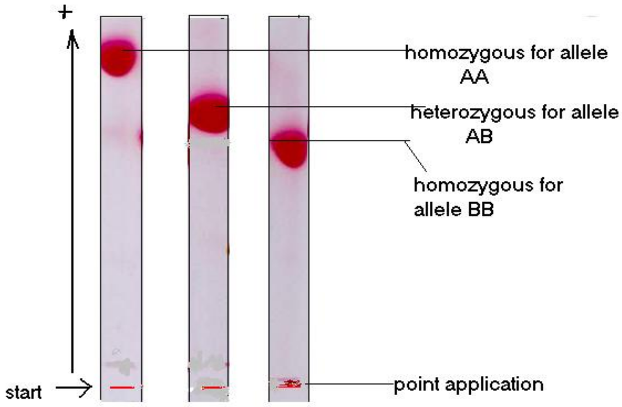

Figure 1 - Relative position of sheep haemoglobin types

Satistically analysis

Data were statistically analyzed using the GLM procedure of the SAS package, 8.1 version (SAS, 1996). Analysis was performed according to the following linear model: $Yij = \mu + Hi + eij$ Where: Yij = the trait of study, μ = the overall mean, Hi = the effect of j^{th} haemoglobin types (j = 1, 2 and 3) where 1 = AA; 2 = AB and 3 = BB, eij = Random error particular to ij^{th} observation.

RESULTS AND DISCUSSION

Haemoglobin types (Hb types) in ewes and lambs

a- Distribution and Allelic frequencies: Distribution of Hb types and allelic frequencies for Rahmani ewes and offspring (Rahmani and ½ C ½ R lambs are shown in Table 1. The number of Hb AB ewes was low in all groups. Allelic frequencies were 0.53 for type AA and 0.47 for type BB. Frequency of the B allele was higher than that of the A allele in both (R) lambs and (½ C ½ R) lambs, while A allele was the more frequent in Rahmani ewes (0.53) compared to (0.47) for B allele. In a large number of studies reviewed by Agar et al. (1972), within different breeds of sheep populations, the B allelic frequency was generally much higher than that of A allele. Stormont et al., (1968) reported that in Horned Dorset, gene frequencies were 0.41 and 0.59 for A and B, respectively. While Colombia sheep they were 0.08 for A and 0.92 for B.

Singh et al., (1976) in some indigenous, exotic and cross – breed sheep found that gene frequency of B type haemoglobin (Hb B) in all the flock of indigenous, exotic and crossbreeds was very high and varied significantly from breed to breed, he added that Hb types in sheep are genetically controlled by one pair of allelic genes with Co–dominance and are inherited in a simple Mendelion manner. Dally et al., (1980) reported that the allelic frequencies were 0.35 for A allele and 0.65 for B allele and B allele were most frequent in Dorest crosses. Wang et al., (1991) reported that the distribution of haemoglobin polymorphism was investigated in 11 breeds of domesticated and three genetic groups of wild sheep in the U.S.A, Hb B was more frequent than Hb A in most of the domesticated breeds with a pooled frequency of 0.71. The Hb B gene frequencies were (0.95 for Barbados), (0.45 for Booroola), (0.77 for Columbia), (0.40 for Finn sheep), (0.87 for Hamshire), (0.88 for Karakul), (0.98 for Rambouillet flock 1), (0.93 for Rambouillet flock 2), (0.12 for Romanov), (0.50 for St-Croix flock 1), (0.63 for St-Croix flock 2), (1.0 for Suffolck flock 1), (0.86 for Suffolck flock 2) and (0.86 for Targhee) all the wild sheep tested (Argali x European Mouflon cross, Asiatic Mouflon X European Mouflon cross and desert Bighorn) were monomorphic for Hb B the monomerphism of Hb B of wild sheep and the higher frequency of Hb B than Hb A in domesticated sheep indicates that Hb A probably occurred after sheep were domesticated. The variation in haemoglobin polymorphism within and between breeds may have resulted from a combination of genetic drift and selection. Morsy (2002) reported that distribution of Hb types and allelic frequencies were 45% for type A and 55% for type B, frequency of the B allele was higher than that of the A allele in both Chios and Ossimi ewes. While A allele was the more frequent in ½ C ½ O crossbred ewes 53% compared to 47% for B allele the number of Hb AB ewes was low in all groups.

Table 1 - Distribution of haemoglobin types (Hb) and allelic frequencies of ewes and lambs

Items	No. of Animals			Allelic frequency	
	AA	AB	BB	A	B
Ewes:					
Rahmani	83	46	71	0.53	0.47
Lambs:					
Rahmani	12	11	18	0.43	0.57
½ C ½ R	6	8	17	0.32	0.68

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b- Relationship between Haemoglobin types and reproductive performance

Reproductive performance is one of the most important criteria to be considered in planning for sheep improvement. The main measurements of reproductive performance were included in the present study being fertility and litter size at birth (prolificacy).

Fertility

Least Squares Means (LSM ± SE), analysis of variance and the significant levels for some factors affecting fertility are illustrated in Table 2.

Haemoglobin type (Hb) had no significant effect on fertility in this study. However, fertility was highest for Hb AA ewes 71%; Hb AB ewes were intermediate 70 % and Hb BB ewes had the lowest value 66%. The present results are consistent with those reported by King et al. (1958), Meyer et al. (1967), Mayo et al (1970) and Guney and Darcan (2000). King et al. (1958) reported that in Scottish Blackface breed, Hb AA ewes were more fertile than either Hb BB or Hb AB ewes, also Meyer et al (1967) reported that among Black headed Mutton sheep in Germany; Hb AA ewes were more fertile than Hb BB ewes. Work done on Australian Merinos by Mayo et al (1970) indicated no differences in fertility attributable to Hb types. Guney and Darcan (2000) working on Fawn x Hair crossbred does, reported that does with Hb AA had higher fertility (80%) than does with Hb BB (70%) and the differences statistically were not significant.

Age of dam had a significant ($P<0.05$) effect on fertility in the present study Table (2). Ewes aged ≤ 4 year – old or more tended to be the most fertile, while ewes aging ≤ 3 year – old or less had the least fertility values (Table 2). Similar results were reported by Vesely and Peters (1981), Long et al. (1989), Sallam et al. (1987), Marzouk (1997), Bourfia and Touchberry (1993), Marzouk and Mousa (1998) and Thieme et al. (1999). The effects of years of mating on fertility of ewes were not significant (Table 2).

Significant effect ($P<0.01$) of mating season on fertility was observed, autumn season (Sept– Oct) was the best season in fertility (84%) compared to (60%) in summer (May – Jon) and (64%) in winter season (Jun – Feb.). This finding is in agreement with those reported by Fahmy (1990), Marzouk (1997), Marzouk and Mousa (1998) and Tosh et al., (2002). Marzouk (1997) reported that fertility value in autumn season was (79%) compared to summer (66%) and winter (54%) seasons. Breed of sire had no significant effect on fertility in this study. Ewes sired by Rahmani rams had the highest fertility (73%) compared to sired by Chios (C) rams (66%). The present results are in agreement with the findings of, Bunge et al., (1993 a, 1993 b) and Bunge et al., (1995).

Table 2 - LSM ± SE of factors affecting fertility and litter size in Rahmani sheep

Items	No of ewes mating	Fertility LSM ± SE	No of ewes	Litter size at birth LSM ± SE
Overall mean	200	0.69 ± 0.045	137	1.05 ± 0.24
Haemoglobin type		NS		NS
Hb " AA "	83	0.71 ± 0.05 a	58	1.01 ± 0.03 b
Hb " AB "	46	0.70± 0.06 a	34	1.02 ± 0.04 ab
Hb " BB "	71	0.66± 0.05 a	45	1.12 ± 0.03 a
Age of dam		*		NS
≤ 2 yr – old	32	0.44 ± 0.08 a	15	1.00 ± 0.06 b
≤ 3 yr – old	70	0.66± 0.05 a	44	1.07 ± 0.03 b
≤ 4 yr – old	46	0.80 ± 0.07 a	36	1.09 ± 0.04 a
≤ 5 yr – old	20	0.78 ± 0.10 a	17	1.05 ± 0.06 b
> 5 yr – old	32	0.77 ± 0.08 a	25	1.03 ± 0.05 b
Year of mating/Lambing.		NS		NS
2002	70	0.82 ± 0.05 a	54	1.05 ± 0.03 a
2003	67	0.65 ± 0.06 a	46	1.06 ± 0.05 a
2004	63	0.61 ± 0.06 a	37	1.04 ± 0.02 a
Season of mating		**		NS
Autumn (Sept–Oct)	64	0.84 ± 0.06a	51	1.10 ± 0.03 a
Summer (May–Jon)	66	0.60± 0.05 b	48	1.00± 0.04 b
Winter (Jun–Feb)	70	0.64 ± 0.05 b	38	1.04± 0.03 ab
Breed of sire		NS		NS
Rahmani rams	104	0.73 ± 0.04 a	74	1.06 ± 0.03 a
Chios rams	96	0.66 ± 0.04 b	63	1.04 ± 0.03a

a, b,: Means within the same classification followed by different letters significantly ($P < 0.05$). ** = $P < 0.01$; * = $P<0.05$; NS=$P > 0.05$.

Litter size at birth (prolificacy)

The effect of haemoglobin type on litter size at birth was not significant. However, prolificacy was highest for Hb BB ewes (1.12), with Hb AB ewes the average was intermediate (1.02) and Hb AA had the lowest value (1.01). The present results are in agreement with the findings of Evans and Turner (1965) reported that Hb BB Merino ewes had significantly higher lambing rates than did Hb AA ewes, also. Agar et al. (1972) reviewed a number of studied of various breeds in diverse environments in which the same conclusion was reached, also similar results reported by Bugne et al. (1990), Guney and Darcan (2000) and Morsy (2002).

Age of ewes was not significant effect on litter size at birth. Ewes aged ≤3 yr-old and ≤4 yr-old had the highest values (1.07 and 1.09) followed by ewes aging ≤ 5 and >5 yr-old (1.05 and 1.03), ewes aged 2 year – old or less had the lowest value (1.0). These results can be explained in the light of the fact that older ewes (4 years old)

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had a mature body size and better conformation. These provide higher ovulation rate and convenient uterus cavity that help percentage of twins. The nursing ability as well as the milk production merit is stronger in the older ewes than young ones. These results follow the same trend as reported by Sidwell and Miller (1971), Dickerson and Glimp (1975), Hohenboken et al. (1976), Paul et al. (1978). Fogarty et al. (1984), Hassan and Sallam (1988), However, Thieme et al., (1999) reported that age of ewe were highly significant for prolificacy, also, Cloete et al., (2000) working on Dorper sheep found that litter size of Dorper ewes was affected by dam age multiple birth rate increasing to an age of 4 – 6 years followed by a tendency towards a decline.

Effects of lambing year on litter size at birth were not significant, while the effect of season of lambing on litter size at birth was not significant. Litter size at birth of ewes mating in autumn season was higher than that mating in winter season (1.10 vs. 1.04), ewes mating in summer season had the lowest value (1.0). The significant effect of season of lambing may be due to variations in environmental factors such as availability of feeds. Similar results were reported by Othman et al. (1994), Younis et al. (1996), Hassan (1988). Breed of sire had insignificant effect on litter size at birth for (Table 2). A ewe mating with Rahmani rams was higher prolificacy than ewes mating with Chios ram (1.06 vs. 1.04). These results follow the same trend as reported in the literature by Bunge et al. (1990) reported type of ram were not significant effect on prolificacy. Also, Bunge et al. (1993b) reported breed of ram was no significant effect on prolificacy, while Bunge et al. (1995) noticed that breed of sire had a significant effect on prolificacy.

c- Relationship between Haemoglobin type and body weight and gain of lambs:

Haemoglobin type in this study was not significant effect on body weights of Rahmani lambs or F1 crosses ½ C ½ R at all ages studied Tables (3, 4, 5 and 6). Least squares means and standard error of factors affecting body weight of Rahmani lambs at different ages according to their (Hb) type Table 3 cleared that lambs with Hb BB had the highest value of weights at all ages studied except birth weight. Also, lambs F1 crosses ½ C ½ R with Hb AA had the highest value of weights at all ages studied except weaning weight.

Differences in daily gain due to Haemoglobin type of Rahmani or F1 cross ½ C ½ R lambs were not significant effect at all periods studied (Tables 5 and 6). From least square means in Tables (5 and 6) it can be noticed that Rahmani lambs with Hb BB had the highest value of daily gain than lambs with Hb AB or Hb AA, while Rahmani lambs with Hb AA had the highest value at third period (from 6 to 9 months) than lambs with Hb AB or BB. On the other hand, lambs from F1 cross ½ C ½ R with HbBB had the highest value at birth, while lambs with HB AA had the highest value at second period (from weaning to 6 months) and four period (from birth to yearling) (Table 6). Similar results were reported by Nihat et al. (2003).

Table 3 - Least squares means ± standard errors of body weight of Rahmani lambs at different ages according to their (Hb) type

Items	No of lambs	Birth weight (kg)	No of lambs	Weaning weight (kg)	No of lambs	Weight at 6 months (kg)	No of lambs	Weight at 9 months (kg)	No of lambs	Weight at yearling (kg)
Overall mean	41	4.20 ± 0.667	40	14.7 ± 3.0569	40	21.6 ± 4.385	38	26.4 ± 4.28	38	34.5 ± 6.17
Hemoglobin Type		NS		NS		NS		NS		NS
AA	12	4.05 ± 0.19 a	12	14.6 ± 0.88 a	12	20.4 ± 1.2 a	12	25.6 ± 1.2 a	12	34.0 ± 1.7 a
AB	11	4.30 ± 0.20 a	10	14.1 ± 0.96 a	10	21.1 ± 1.3 a	9	25.9 ± 1.4 a	9	33.6 ± 2.0 a
BB	18	4.14 ± 0.15 a	18	15.4 ± 0.72 a	18	23.3 ± 1.0 a	17	27.8 ± 1.0 a	17	35.9 ± 1.4 a

Table 3- Least squares means ± standard error of body weight of Crossbred (½ C ½ R) lambs at different ages according to their (Hb) type

Items	No of lambs	Birth weight (kg)	No of lambs	Weaning weight (kg)	No of lambs	Weight at 6 months (kg)	No of lambs	Weight at 9 months (kg)	No of lambs	Weight at yearling (kg)
Overall mean	30	4.6 ± 0.70	30	18.3 ± 2.5	30	25.9 ±3.7	28	31.7± 5.1	28	40.1 ± 6.5
Hemoglobin Type		NS		NS		NS		NS		NS
AA	6	4.9 ± 0.28 a	6	18.8 ± 1.05 a	6	27.7 ± 1.5 a	6	33.7 ± 2.1 a	6	42.5 ± 2.1 a
AB	6	4.2 ± 0.28 a	6	17.1 ± 1.05 a	6	23.8 ± 1.5 a	5	29.4 ± 2.3 a	5	36.9 ± 2.9 a
BB	18	4.6 ± 0.16 a	18	19.0 ± 0.60 a	18	26.3 ± 0.8 a	17	32.0 ± 1.2 a	17	40.8 ±1.5 a

Table 5 - Least Squares Means ± Standard errors of daily gain (kg) of Rahmani lambs at different ages according to their (Hb) type

Items	No of lambs	Daily gain from birth to weaning	No of lambs	Daily gain (kg) from weaning to 6 months	No of lambs	Daily gain from 6 to 9 months (kg)	No of lambs	Daily gain from birth to yearling (kg)
Overall mean	40	0.117 ± 0.0025	40	0.076 ± 0.008	38	0.056 ± 0.0098	38	0.084 ± 0.0122
Hemoglobin Type		NS		NS		NS		NS
AA	12	0.117 ± 0.008 a	12	0.065 ± 0.008 a	12	0.061 ± 0.005 a	12	0.084 ± 0.003 a
AB	10	0.108 ± 0.009 a	10	0.078 ± 0.009 a	9	0.053 ± 0.006 a	9	0.080 ± 0.004 a
BB	18	0.125 ± 0.007 b	18	0.084 ± 0.007 b	17	0.053 ± 0.004 a	17	0.088 ± 0.002 a

Table 6 - Least Squares Means ± Standard errors of daily gain (kg) of Crossbred (½ C ½ R) lambs at different ages according to their (Hb) type

Items	No of lambs	Daily gain from birth to weaning	No of lambs	Daily gain (kg) from weaning to 6 months	No of lambs	Daily gain from 6 to 9 months (kg)	No of lambs	Daily gain from birth to yearling (kg)
Overall mean	30	0.153 ± 0.0058	30	0.085 ± 0.0081	28	0.066 ± 0.0085	28	0.097 ± 0.0022
Hemoglobin Type		NS		NS		NS		NS
AA	6	0.155 ± 0.010 a	6	0.098 ± 0.011 b	6	0.067 ± 0.011 a	6	0.103 ± 0.009 b
AB	6	0.144 ± 0.010 b	6	0.074 ± 0.011 a	5	0.067 ± 0.012 a	5	0.089 ± 0.009 a
BB	18	0.160 ± 0.006 a	18	0.082 ± 0.006 a	17	0.064 ± 0.006 a	17	0.098 ± 0.005 a

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