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Effects of Seasonal Changes and Shearing on Thermoregulation, Blood Constituents and Semen Characteristics of Desert Rams (*Ovis aries*)

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Abstract: This experiment was designed to study the effects of shearing in different seasons (winter vs. summer) on thermoregulation, blood parameters and semen characteristics of desert rams. Eight intact healthy rams were randomly assigned into two groups (n = 4). The control group was kept unshorn (UN) with intact pelage, the mean length of hair left was approximately 1.5 cm and the treated group was shorn (SH). Rectal temperature (Tr) and Respiration Rate (RR) measurements were carried out twice daily throughout the experimental period. Blood samples were collected once weekly for the evaluation of Packed Cell Volume (PCV), Total (TLC) and Differential (DLC) leukocyte count, Serum Total Protein (STP), Serum Albumin (SA), Serum Urea (SU) and Plasma Glucose (PG) concentration. Semen samples were collected once weekly for the determination of Ejaculate Volume (EV), Sperm Mass (SM) and individual (SIM) motility, Sperm Cell Concentration (SCC), live (LSP) and abnormal (ABS) sperm percent and semen pH. Scrotal Circumference (SC) measurements were performed weekly. Shearing of desert rams significantly lowered the morning Tr in both seasons and the afternoon Tr during summer ,while RR was significantly lower in both seasons in the afternoon. The PCV was significantly lower in shorn rams during summer compared to winter and PG was significantly higher during winter compared to summer. In both seasons shearing significantly lowered SIM. It is concluded that shearing significantly affected thermoregulation, blood composition and semen characteristics during winter and summer. It is concluded that shearing in different season significantly affected thermoregulation, blood parameters and seminal traits of Desert Hamari rams.

Key words: Rams, shearing, season, thermoregulation, blood, semen

INTRODUCTION

In the tropics, most mammals are of hairy coat (Macfarlane, 1968) and Desert sheep are exclusively haired (Mcleroy, 1962). Exposure of sheep to climatic stress and seasonal changes affect their heat balance and physiological responses. Heat tolerance is a complex association between ambient temperature, humidity, radiation (Mohamed *et al.*, 2012), avenues of evaporative heat loss and coat characteristics (Hofman and Riegle, 1977). In the tropics, the insulation of the hairy coat of sheep increases with coat thickness and hair density (Bennett and Hutchinson, 1964). In the hot humid tropics, where high ambient temperature and relative humidity may contribute more to heat stress than solar radiation, a thick coat may not be an advantage; however, wooly coats can be an advantage in animals that pant to lose heat (Yeates *et al.*, 1975). The thermal resistance to the flow of heat from skin to the surface of the pelage depends upon the entrapped air which occupies over 95% of the volume of hair coat. In sheep, a protective fleece will help to combat the effects of radiation through the insulation and cutaneous evaporation (McArthur and Monteith, 1980).

The physical characteristics of coat are modified in response to seasonal changes in thermal environment of the tropical and subtropical areas. The growth of body coat increases during winter and decreases during summer (Grell, 1977). The colour of the pelage controls the degree of radiant heat reflection, as the white color reflects a higher proportion of radiant heat and the black colour absorbs it (Cena, 1973). The coat insulation represents thermal resistance to the flow of heat from the skin to the surface of the hair coat and its presence helped reduce the rise in both rectal temperature and respiratory rate when sheep were exposed to high ambient temperature (Lee, 1950). Shearing of sheep increases the reflectivity of fibres (Cena, 1973) it is supposed to alleviate thermal stress and offer a number of husbandry advantages. Shearing of Desert sheep facilitates heat dissipation when environmental temperature is below

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body temperature (Ahmed, 1989). Exposure of shorn sheep to direct solar heat increased heat gain and body temperature and induced changes in energy balance and fluid dynamics (Macfarlane *et al*., 1966; Kaushish *et al*., 1976), with consequent increases in water intake, water turnover rate and extracellular fluids. However, winter shearing markedly influenced the heat balance of sheep (Turnpenny *et al*., 2000), as body core temperature tended to be lower, particularly in the morning due to enhancement of heat loss via the skin (Eyal, 1963a, b; Kaushish *et al*., 1976).

Shearing of sheep may induce physiological and metabolic responses which influence blood volume and composition. Heat exchange alterations induced by shearing increased skin blood flow related to vasodilatation and reduction in vasomotor tone (Bianca, 1968). Summer shearing of Merino wethers increased plasma volume (Macfarlane *et al*., 1966). Shearing influences the availability of nutrients for blood constituents through its effects on feed and water intake, as they are modulated by changes in environmental temperature. Low ambient temperature increased the energy requirements of sheep (Thompson and Cheeke, 2005), which was associated with decreased digestibility. However, at high ambient temperature, decreased food intake was associated with the demand for evaporative heat loss and high water turnover rate (Abdelatif and Ahmed, 1993). These changes are usually associated with marked disturbances in the metabolism of energy and water (Macfarlane, 1968).

In rams, the scrotum is ventrally located and it is protected from direct solar radiation. In hot environments, a heavy scrotal wool growth will impede evaporation, thus preventing the efficiency of cooling and interfering with spermatogenesis (Kastelic *et al*., 1996, 1997). Pijoan and Williams (1984) reported that shearing of rams before the hot season reduced the adverse effects of heat stress on semen quality. This response is related to enhancement of cutaneous evaporation and scrotal sweating which provide an effective thermoregulation mechanism and increase heat tolerance of rams (Alexander, 1973). However, Hullet *et al*. (1956) observed a high semen quality and fertilizing rate in shorn Hampshire, Shropshire Oxford and Corriedale rams during winter compared to hot season. In unshorn Chokla rams with closely clipped scrotum, the relative sweating response, compared to the other body regions, was higher due to the large number of scrotal sweat glands which resulted in lowered body temperature (Rai *et al*., 1979).

However, there is dearth of information regarding the effects of interaction between shearing and thermal environment on blood metabolites and seminal traits of Desert rams. The main objective of this experiment was to investigate the effects of shearing Desert rams during winter and summer on thermoregulation, blood constituents and semen characteristics.

MATERIALS AND METHODS

Location and climate: This experiment was carried out at the University of Khartoum Farm at Shambat. The climatic data were obtained from Shambat Meteorological Station which is located about 1 km from the site of the experiment.

Animals and management: Eight intact healthy Desert Hamari rams were randomly assigned to two groups of 4 rams each and kept under broken shade. The rams were selected following proper clinical screening of external genitalia and semen evaluation.

In each season, both groups of rams were allowed an adaptation period of 2 weeks during which they were dewormed and given prophylactic doses of antimicrobial therapy. They were allowed to graze daily from 7:00 a.m. to 2:00 p.m. and allowed free access to tap water, followed by an experimental period of 3 months. The control group was kept unshorn with intact pelage, the mean length of hair was about 1.5 cm and the treated group was shorn. Shearing was performed using a manual shearing machine; the mean length of hair left was approximately 0.5 cm in both seasons.

Measurements: During the experimental period measurements were conducted with a similar protocol during winter and summer. The measurements of rectal temperature (Tr) and respiration were performed weekly in the morning (7:00 a.m.) and in the afternoon (2:00 p.m.). The rectal temperature (Tr) was measured to the nearest ±0.1°C using certified mercury-in-glass clinical thermometer (Wilson-Supreme, Japan) and the Respiration Rate (RR) was measured visually by counting the flank movements with the aid of stop-watch the values were taken for one minute of regular breathing with the animal standing quietly (Mohamed and Abdelatif, 2010).The Scrotal Circumference (SC) was measured weekly to the nearest±0.1 cm according to the method described by Boundy (1992).

Samples collection

Blood samples: Blood samples were collected weekly from rams under aseptic conditions from the jugular vein using plastic disposable syringes. A sample of 5 mL was collected and immediately 1 mL was transferred to a test tube with anti-coagulant (Tri-sodium ethylene-diamine-tetra-acetate, EDTA) for the measurements of the erythrocytic and leukocytic indices. About 2 mL of blood was also transferred to a test tube with anticoagulants, EDTA and sodium fluoride (Kelly, 1984), these samples of blood were centrifuged for extraction of plasma samples for glucose determination. The rest of the blood samples were centrifuged for extraction of serum samples for the measurements of metabolites concentration.

Semen samples: Semen samples were collected weekly by electro-ejaculation according to the standard method (Blackshaw, 1954; Boundy, 1993; Mohamed, 1997) using the Raukura ram design of probe (Mark IV OLVET, New Zealand).

Samples analysis

Blood samples: The analyses of blood samples were carried out according to the standard methods described in Schalm's Veterinary Haematology (Jain, 1986).

Blood samples were used for the determination of PCV, total (TLC) and differential (DLC) leukocyte counts. Serum samples were used for the measurements of the concentrations of total protein (STP), albumin (SA) and urea (SU) and plasma samples were used for the determination of glucose concentration (PG).

Semen samples: The samples were examined immediately after collection to the standard techniques and methods (Boundy, 1993; Mohamed *et al*., 2012). Semen samples were used for the determination of Ejaculate Volume (EV) and the analysis of Sperm Mass(SM) and individual motility(SIM), Sperm Cell Concentration(SSC), Live Sperms Percent(LSP), morphologically abnormal sperms(ABS) and semen pH.

Statistical analysis: The statistical analysis was performed using the Statistical Analysis System (SAS, 1997). The analysis of variance (ANOVA) test was used to evaluate the effects of season and shearing on thermoregulation, blood constituents and semen characteristics of Desert rams and the results obtained were presented as means±S.E.

RESULTS

Climatic data: Climatic condition are explained in Table 1.

Rectal temperature (T_r) and Respiration Rate(RR): The results indicated that the thermoregulation of Desert rams were influenced by season and shearing (Table 2). Shearing significantly ($p<0.05$) lowered the morning rectal temperature (T_r) values in both seasons and the afternoon T_r value during summer only compared to values obtained for the control group. The seasonal change in the afternoon T_r was significant ($p<0.05$) in unshorn rams and both groups showed a diurnal pattern in T_r irrespective of season. The diurnal changes in T_r for unshorn rams were 1.0 and 0.82°C in summer and winter, respectively. The corresponding changes in T_r for shorn rams were 1.08 and 2.03°C, respectively. Both unshorn and shorn rams maintained significantly higher Respiration Rate (RR) during summer morning ($p<0.05$) compared to winter values. In the afternoon, shearing was associated with a significant ($p<0.05$) decrease in RR in both seasons. Both group of rams had significantly ($p<0.01$) higher RR values during summer compared to respective values obtained winter. Both groups of rams showed a diurnal pattern in RR in both seasons. For the unshorn rams, the diurnal changes in RR were 48 and 16 breaths min^{-1}, for summer and winter, respectively. The corresponding changes in shorn rams were 31 and 6 breaths min^{-1}, respectively.

Blood analysis: The results indicated that certain blood constituents were influenced by the experimental treatments (Table 3). Shearing of Desert rams significantly

Table 1: Ambient temperature (Ta) and relative humidity (RH) during the experimental period

	Season							
	Winter				Summer			
	Ta (°C)			RH(%)	Ta (°C)			RH(%)
Time (weeks)	Max.	Min.	Mean.	Mean	Max.	Min.	Mean.	Mean
1	28.3	12.7	20.0	23.0	42.2	23.8	33.0	14.0
2	32.4	14.1	23.5	27.0	43.3	22.9	33.1	14.0
3	30.4	14.6	22.5	25.0	41.5	27.0	34.3	17.0

Table 2:.Effects of season and searing on rectal temperature (Tr) and respiration rate (RR) of Desert rams (n = 16)

	Rectal temperature, T (°C)				Respiration rate (RR)			
	7:00 a.m		2:00 p.m.		7:00 a.m.		2:00 p.m.	
Parameters	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Treatment/unshorn	38.23±0.07 ^{Aa}	38.98±2.23^{Aa}	39.44±4.11^{Ab}	39.98±0.06^{Aa}	23.75±0.77^{Ab}	31.75±3.90^{Aa}	39.05±0.06^{Ab}	79.50±7.80^{Aa}
Shorn	73.07±0.19 ^{Ba}	37.84±0.12^{Ba}	38.90±0.05^{Aa}	38.92±0.08^{Ba}	21.50±0.72 ^{Ab}	30.25±4.52^{Aa}	27.75±1.29^{Bb}	65.75±6.94 ^{Ba}

Values (mean±SE), for each parameter, with different lower case letters in the same row and with different upper case letters in the same Column differ significantly ($p<0.05$)

Table 3: Effects of season and shearing on blood parameters of desert rams (n = 16)

Parameters	Blood parameters: PCV (%)		Total leukocyte count TLC ($\times 10^3$ µL^{-1})		Glucose conc (mg dL^{-1})		Total protein con. (g dL^{-1})		Albumin conc. (g dL^{-1})		Urea conc. (g dL^{-1})	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
Treatmment/ Unshorn	28.63±1.32^{Aa}	26.00±0.79^{Aa}	6.33±0.54^{Aa}	6.28±0.44^{Aa}	56.01±1.38^{Ba}	55.68±1.44^{aA}	7.34±0.21^{Aa}	7.29±0.15^{Aa}	4.13±0.1^{Aa}	3.50±0.0^{Ab}	22.48±2.42^{Aa}	19.70±1.15^{Aa}
Shorn	29.06±1.11^{Aa}	25.81±0.73^{Ab}	6.11±0.40^{Aa}	5.25±0.30^{Aa}	64.40±2.89^{Aa}	58.10±1.51^{Ab}	7.40±0.17^{Aa}	7.13±0.19^{Aa}	3.90 ±0.08^{Aa}	3.55±0.05^{Aa}	24.13±2.28^{Aa}	20.32±1.34^{Aa}

Values (mean±S.E.) within the same row bearing similar lowercase (small) letters, and values within the same column bearing similar upercase (capital) letters are not significantly different at $p<0.05$

Table 4: Effects of season and shearing on differential leukocyte count, DLC in desert rams (n = 16)

	Season			
	Winter		Summer	
Cell type (%)	Unshorn	Shorn	Unshorn	Shorn
Lymphocytes	59.00±2.51	54.06±2.01	58.81±1.51	56.50±1.65
Neutrophils	34.13±2.85	38.31±2.20	34.31±1.50	38.06±1.73
Eosinophils	2.25±0.72	2.50±0.52	1.13±0.24	1.63±0.36
Monocytes	4.63±0.63	5.13±0.88	5.75±0.99	3.81±0.59

Values are Mean±SE

($p<0.05$) decreased the Packed Cell Volume (PCV) level during summer. The current results revealed that in unshorn rams, the Serum Albumin (SA) concentration was significantly ($p<0.05$) higher during winter compared to summer values. Compared to unshorn rams and summer values, winter shorn rams maintained a significantly ($p<0.05$) higher plasma glucose level in winter. However, shearing did not significantly influence the Differential Leukocytic Count (DLC) of desert rams (Table 4).

Semen analysis: Shearing and seasonal change influenced semen characteristics (Table 5). A significant reduction in the Ejaculate Volume (EV) was observed in unshorn ($p<0.05$) and shorn ($p<0.01$) rams during summer compared to winter values. The sperm mass motility (MM) of both groups of rams was significantly ($p<0.05$) lower during summer compared to winter values. During both seasons, shearing of rams was associated with a significant decline in Sperm Individual Motility (SIM) in winter ($p<0.01$) and summer($p<0.05$) . However, SIM of the unshorn rams was significantly ($p<0.05$) lower during summer compared to winter values. The Live Sperm Percent (LSP) was significantly ($p<0.05$) lower during summer compared to winter in both groups of rams.

The abnormal sperm percent (ABS) of both groups of rams was significantly higher ($p<0.01$) during summer compared to winter values.

DISCUSSION

The different responses for the thermoregulation mechanism indicated that both groups of rams were influenced by the high ambient temperature prevailing during the experimental period (Table 1). The observed reduction in T_r in response to shearing could be related to the facilitated heat dissipation via sensible means with the reduction of hairy coat insulation. Also this response indicates changes in heat balance of Desert rams induced by seasonal changes in thermal environment (Mohamed and Abdelatif, 2010). Mittal and Ghosh (1979) noted that the T_r of shorn Corriedale rams was positively correlated to the prevailing ambient temperature. Moreover, Azamel *et al*. (1987) indicated that shearing of Barki and Barki Merino cross sheep decreased T_r under subtropical summer conditions due to the increase of heat loss by sensible channels. In Desert rams (Ahmed and Abdelatif, 1993) reported lower T_r values after shearing. During winter morning, low T_r values were reported in shorn outbred sheep (Slee *et al*., 1988), Suffolk rams (Sano *et al*., 1995) and Dorset sheep (Entin *et al*., 1998). However, lower T_r values were reported during summer shearing in Awassi rams (Youmis *et al*., 1977) and Chokla and Nali ewes (Gupta and Acharya, 1987). Conversely, higher T_r values were reported for shorn Merino rams (Klemm, 1962) and Merino sheep (Macfarlane *et al*., 1966) during summer compared to values reported to unshorn group; this response was attributed to penetration of sun rays to the skin surface. However, the high T_r values reported in shorn Comisana, Barbaresca, Siciliana and Pinzirita sheep during cold season compared to that reported for the unshorn was associated with elevation of core temperature which was attributed to an over-reaction to the mild cold stress resulting from shearing (Piccione *et al*., 2002).

Summer heat enhanced the evaporative heat loss in both groups of rams throughout the day. In unshorn sheep, the fleece exerts an extra conduction of heat during hot season (Graham *et al.,* 1959; Parer, 1963). Elhadi (1988) reported that in arid areas, the high radiant energy heats up the fleece of unshorn and skin of shorn sheep which adds to stress produced by high environmental temperature and enhances evaporative heat loss. High RR values were reported during the hot season in shorn Merino sheep (Klemm, 1962; Macfarlane *et al*., 1966), Targhee rams (Hofmeyr *et al*., 1969) and Najdi rams (Elhadi, 1988). The low value of RR obtained in both seasons for the shorn rams in afternoon could be attributed to increased evaporative heat loss from the skin surface and respiratory tract. Azamel *et al*. (1987) reported low RR values in shorn Barki and Barki -Merino cross rams during summer and attributed this to enhancement of heat loss through the evaporative channels. Shearing during summer was associated with a significant decrease

Table 5: Effect of season and shearing on semen characteristics of desert rams (n = 16)

Parameters	Ejaculate volume EV (mL)		Mass motility (SM)		Individual motility (SIM)		Cell conc. (SSC) ($\times 10^9$ mL^{-1})		Live sperm (LSP) %		Abnormal sperm (ABS) %		Semen pH	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winte	Summer	Winte	Summer
Treatment/ Unshorn	1.32 ± 0.13^{Aa}	0.86 ± 0.12^{Ab}	3.56 ± 0.40^{Aa}	3.38 ± 0.14^{Ab}	53.33 ± 6.40^{Aa}	41.56 ± 4.02^{Ab}	1.59 ± 0.20^{Aa}	1.53 ± 0.52^{Aa}	98.59 ± 0.33^{Aa}	96.19 ± 0.83^{Ab}	1.39 ± 0.26^{Ab}	5.08 ± 1.21^{Aa}	7.56 ± 0.04^{Aa}	7.61 ± 0.11^{Aa}
Shorn	1.39 ± 0.09^{Aa}	0.55 ± 0.16^{Ab}	3.53 ± 0.18^{Aa}	3.25 ± 0.36^{Ab}	38.00 ± 3.23^{Ba}	34.18 ± 3.41^{Ba}	2.08 ± 0.18^{Aa}	1.64 ± 0.65^{Aa}	98.14 ± 0.53^{Aa}	95.90 ± 0.67^{Ab}	2.03 ± 0.47^{Ab}	6.58 ± 1.81^{Aa}	7.67 ± 0.06^{Aa}	7.72 ± 0.10^{Aa}

Values (mean±S.E.) within the same row bearing similar lowercase (small) letters, and values within the same column bearing similar upercase (capital) letters are not significantly different at $p<0.05$

in RR of Awassi rams (Youmis *et al*., 1977), Chokla and Nali ewes (Gupta and Acharya, 1987). However, winter shearing of Suffolk rams induced a significant decrease in RR (Sano *et al*., 1995).

The reduction in PCV level in response to summer shearing could be associated with an increase in water intake, water turnover and total body water during summer. (Macfarlane *et al*., 1966) reported an increase in extracellular fluid of shorn Merino sheep in hot environment; this response was associated with increased respiration rate. Elhadi (1988) observed significant increases in water turnover and total body water in summer shorn Najdi rams and this was associated with marked polypnoea. However, the observations of Ahmed and Abdelatif (1993) indicated that shearing of Desert rams under mild environmental conditions induced a slight decrease in PCV level.

The high level of SA concentration reported for unshorn rams during winter, could be associated with increased food intake in the rather cool environment and elevation of the nutritional status of the animals due to improvement of pasture. Also it could be related to decrease in water turnover rate and relative haemoconcentration. A significantly higher serum albumin concentration was reported in unshorn Desert rams by Ahmed and Abdelatif (1993).

The change in SPG level is most likely related to the increase in food intake due to the increase in energy demand for thermogenesis. An increase in voluntary food intake following shearing at low ambient temperature was reported in sheep (Minson, 1971, Vipond *et al*., 1987; Dyrmundsson, 1991). The higher glucose level reported in winter could also be associated with inhibition of insulin secretion during cold stress. Symonds *et al.* (1989) noted higher concentration of glucose level associated with decreased insulin level in winter shorn ewes. Sano *et al.* (1995) reported high glucose concentration in Suffolk rams shorn during cold conditions and attributed this response to increased turnover of blood glucose through gluconeogenesis.

The low value of EV reported indicates that both groups of rams were influenced by increases in body and scrotal temperatures which coincided with the prevailing ambient temperature (Table 1) and eventually lowered testosterone secretion beside low food intake. Low semen characteristics were indicated during hot season in rams (Moghaddam and Pourseif, 2012). Waites and Voglmayr (1963) reported low evaporative sweating in unshorn scrotum of Merino and Border Leicester rams with heating. However, the authors noted an increase in sweating in shorn scrotum. In the current study, shearing of Desert rams and their scrota during summer could have impaired thermoregulation and induced alternations in accessory genital gland functions and spermatogenesis. Kastelic *et al.* (1996) indicated altered scrotal thermoregulation in Merino rams under heat stress.

In both groups, the reduction in summer values of SM is clearly associated with increased scrotal temperature which adversely affects testicular acquired SM. Similarly summer heat stress significantly lowered SM of Desert rams (Galil and Galil, 1982) and Chios cross rams (Ibrahim, 1997) under subtropical conditions.

The reduction in SIM reported in response to shearing in both seasons could be attributed to exposure of shorn scrotum to radiant heat from the surrounding or from the ground while the animals are lying during the experimental period in winter ($p<0.01$) and summer ($p<0.05$) compared to the control resulting in increased testicular and epidydimal temperature during sperms transit and preservation. The prevailing high ambient temperature and radiant heat may account for the extra heat load on testes and epididymis. Kastelic *et al.* (1997) reported that high scrotal and epididymal temperature interferes with sperm production and motility.

The effect of summer season on LSP in both groups is presumably associated with increased body temperature. Moreover, the increase in radiant heat on shorn testes could increase testicular temperature and reduce the incidence of LSP. The present results are consistent with the findings of Galil and Galil (1982) and Alsayed (1996) who reported lower percentage of live sperm in Desert rams during summer.

The high values reported for the ABS during summer indicates the adverse effects of summer season on semen characteristics. The summer thermal load increased the incidence of abnormal sperm of unshorn Merino rams (Amir and Volcani, 1965) and Desert rams (Galil and Galil, 1982; Mohamed *et al*., 2012). Heating of the scrotum increased the percentage of abnormal sperm (Dutt and Hamm, 1957; Kishore, 1983; Ibrahim *et al.,* 2001).

CONCLUSION

In conclusion, this study revealed that shearing of desert rams significantly alleviated heat stress; however in both seasons scrotal shearing adversely affected semen characteristics. Further studies are needed to investigate the effects of shorn female fecundity and their conception rates to the semen of shorn rams in different season, to elaborate more views for shearing practice performed in Sudan by nomads and in closed system.

Other studies are also needed to evaluate the effects of shearing on the biochemical, histochemical and histological characteristics of testicular tissues and seminal plasma in the tropics.

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