Journal of Arid Agriculture

J. Arid Agric. 2025, Vol. 26 (1): 16 - 22

0189-7551

INFLUENCE OF WATTLE ON UDDER MEASUREMENTS AND MILK SAMPLES OF RED SOKOTO (*MARADI*) DOES RAISED SEMI-INTENSIVELY IN MINNA, NIGER STATE, NIGERIA

P. S. Kolo[1]*, I. C. Alemede[1], S. S. A. Egena[1], J. Y. Adama[1], A. H. Dikko[1] and M. B. Abubakar[2]

[1] Department of Animal Production, Federal University of Technology, Minna, Niger State, Nigeria.

[2] Department of Animal Production and Health, Federal college of Agriculture Kano

ABSTRACT: A two-year study on the Influence of wattle in Red Sokoto (*Maradi*) goats on udder measurements, milk quantity and quality was carried out at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna. Thirty-six (36) Red Sokoto goats comprising of thirty-two (32) does and four (4) bucks managed semi-intensively were used for the study. Parameters observed included udder circumference, distance between teats, change in udder circumference, change in distance between teats, teat length after milking, milk quantity and quality analysis. Data collected were analyzed using SAS statistical package. After the experiment, it was observed that Crosses between the wattle and the non-wattled had the highest ($p<0.05$) in terms of udder circumference before and after milking, quantity of milk and average daily milking. Wattled does in (T3 and T4) produced the highest ($p<0.05$) peak yield. Wattled does mated with watted bucks (T4) had the highest ($p<0.05$) total milk yield. Non-wattled does mated with non-wattled bucks (T1) and wattled does mated with wattled bucks (T4) had the highest ($p<0.05$) moisture content in the milk sample which reduced the availability of most minerals in the milk. In conclusion, attention should be focused on the crosses between the wattled and the non-wattled Red Sokoto as it gave best result in most parameters examined. Deliberate effort must be made to preserve the wattle gene to prevent the goats carrying the gene from going to extinction.

Key words: Wattle, colostrum, does, udder, milk yield

INTRODUCTION

The Red Sokoto goat is the most predominant goat breed and accounts for about 70 % of Nigeria's total goat population, which have been estimated at 17.5 million (Ademosun, 1994). It is commonly found among the agro pastoralist mainly within the northern sub humid and semiarid zone of the country (Akpa *et al*., 1998). The breed is predominantly reddish brown in colour and is found in the savannah zone of Nigeria (8^{o}N – 11^{o}N) where it constitutes more than 90% of the goat population in the area. The breed weighs about 1.5 – 2.0kg at birth and reaches about 12 kg when weaned at 3 months under good management. Weight of adult does and bucks are 20 – 35kg and 25 – 40kg respectively (Osuhor *et al*., 2002). The skin of Red Sokoto goat is reputed to be of high quality; therefore, it is used in the leather industry locally and internationally (Akpa *et al*., 1998). The Red Sokoto breed have some unique features among which includes the development of wattles.

Wattles are those little tufts of hair that covers the skin that dangles from the throat of some goats. Wattle have been regarded as a structural outgrowth in the body of animals whose function is still under debate Sabbioni *et al*., 2011) but was of the opinion that wattle could be utilized during selection for productive purposes. Research on the incidence and relative effect of wattle traits and its association with body measurements have been done by (Ozoje *et al*., 2001) in West African Dwarf goat. Similarly, several research findings on the association between wattle traits and performance growth, reproduction and heat tolerance) have been done on West African Dwarf goats in the southern part of Nigeria and other goat breed around the world but similar works are limited on indigenous Red Sokoto goat in the Northern part of Nigeria. This study is therefore aimed at assessing the influence of wattle on milk composition and udder parameters of Red Sokoto does.

MATERIALS AND METHODS

Description of Study Area

Corresponding Author: kolo.philip@futminna.edu.ng
Tel. +2347035071871

Journal of Arid Agriculture. 2025, Vol. 26 (1): 16 - 22

The study was carried out at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Minna, Niger State, Nigeria. Minna is located within latitude 9^0 37′ North and longitude 6° 33′ East of the equator. Minna has a mean annual rainfall of 1,300 mm, with an average highest temperature in the month of March and lowest temperature in the month of August. The mean annual temperature is between 22 to 40° C. Minna is located in the Southern Guinea Savannah vegetation belt of Nigeria and has two distinct seasons; wet from March to October and dry from November to March (Federal University of Technology, Minna, Students Handbook, 2017).

Source and Management of the Experimental Animals

Thirty-six (36) Red Sokoto goats comprising of thirty-two does and four bucks were used for the experiment. The does were purchased at a fairly young age of between seven to eight months, in order to avo idthe purchase of pregnant does while males of about one and half to two years were purchased to ensure effecti ve.breeding (the ages of the goats were determined by dental examination). The animals were sourced from with in Niger State, principally from neighbouring communities and goat markets (Minna, Mariga, Beji, Kanfaninbobi and Bida goat markets). The purchased goats were acclimatized to the new environment for a period of eight (8) weeks (this was done purposely to allow the does more time for sexual maturity). During acclimatization, the goats were administered with Ivomectin®; a broad spectrum anti parasitic drug, to remove both internal and exte rnal parasites. Vaccination against peste des petits ruminants (PPR) was done using PPR-VAC®. Broad spectrum anti-biotic (20 % oxyteracycline: Heibei Huarun Pharmacy Co. Ltd., China), penstrep® (Kepro, Holland), envite® multi vitamin (Ventidia pharmaceutical Ltd, India), albendazole® (Jawa International Limited, Lagos, Nigeria) and other drugs were administered when necessary to keep the animals in good health. The pen was constructed from wood and metal sheets. Water was provided *ad-libitum*, feed (yam peels, maize offal, beans husk and sorghum chaff) were given around 9 am every morning before the animals were relased for grazing. The proximate composition of feeds given to the goats is shown in Table 1

Treatments and Experimental Design

After the attainment of sexual maturity, thirty-two does and four bucks were allotted to four treatments in a Completely Randomised Design (CRD). Treatment one (**T_1**) comprised of goats without wattles in both sexes (serving as the control). Treatment two (**T_2**) comprised of does without wattle mated with wattled bucks. Treatment three (**T_3**) comprised of wattled does mated with non-wattled bucks while Treatment four (**T_4**), comprised of wattled bucks and does. Each treatment having eight replicates with each replicate containing one doe. The four bucks were divided among the four treatment groups (one buck per treatment) and were kept separately from the does. The animals were tagged properly for identification. The does were raised semi intensively while the bucks were confined before mating (to prevent unwanted breeding) and raised semi-intensively after mating. The animals were allowed to graze in the day time and housed later in the evening the period of two years

Table 1. Proximate composition of the experimental Diets

Parameters	Yam peel	Maize offal	Beans husk	Sorghum charf
Dry matter (%)	91.09	86.05	87.58	89.28
Crude protein (%)	7.87	14.87	8.75	6.12
Crude fibre (%)	11.70	13.10	32.45	32.90
Ether extract (%)	1.70	2.20	1.60	5.88
Ash (%)	4.80	0.95	8.51	4.21
Nitrogen Free Extract (%)	65.02	54.93	36.27	40.17
Metabolizable Energy (Kcal/g)	307.66	299.09	194.48	238.08

Data Collection

Data collection started after the does had given birth; milk samples from all the lactating does were collected from the first week of lactation to the twelfth week. Milk production was collected once a week by hand milking for the period of twelve weeks. The night before milking, kids were separated from their dams for 12 hours (6:00 pm to 6:00 am). The next morning, the does were completely hand milked and the quantity of milk was recorded. The

milk obtained was multiplied by 2 to obtain the daily milk yield as described by (Bencini *et al.*, 2003). Milk yields was measured using Pyrex measuring cylinder of 2 litre capacity. Other parameters recorded weekly includes:

Udder circumference (cm): This was done using tailoring tape measure (Apollo industries, India). The measurements were taken as the distance round the middle of the udder; this was repeated after milking to observe the effect of milking on the udder.

Distance between teats (cm): This was measured using the measuring tape mentioned above. The measurement was done as the distance between two tips of the teat. The procedures were also repeated after milking to observe the change in distance between the teats.

Teat length (cm): This was done using the above measuring tape. It was measured as the distance between the base of the udder to the tip of the teats. This was also repeated after milking to see the effect of milking on the teat length.

Data on all the above mentioned parameters were recorded weekly from the first week up to 12 weeks of lactation.

Milk Yield Parameters:

First test day yield: This is the milk yield at day 7 post-partum.

Peak yield: This is the highest recorded test day milk yield within the twelve weeks sampling period.

Total yield: This is the summation of the weekly milk production over 90 days post-partum.

Last test day Yield: Milk yield on day 90 post-partum.

The collected samples were fed back to the kids (bucket feeding) whose mothers were milked. Portions of the milk were collected from the does weekly from the 1st week up to the 12th week of lactation for milk quality analysis (dry matter, crude protein, ether extract, ash, milk solid, nitrogen free extract, vitamin and mineral content). The milk samples were quickly transported to the Animal Production Laboratory, Federal University of Technology Minna for analysis.

Data Analysis

Data collected were analyzed using SAS statistical package (SAS, 2000). Means were separated using Duncan Multiple Range Test. Correlation analysis were employed to identify the degree of association between milk yield and udder traits.

RESULTS

The effect of wattle on mean udder parameters and milk yield of Red Sokoto does kept semi intensively is presented in Table 2. The Table revealed a significant ($p<0.05$) difference in all the parameters measuered except in teat length before milking and the last test day milk yield. Non-wattled does mated with wattled bucks (T_2) and wattled does mated with non-wattled bucks (T_3) were statistically ($p>0.05$) the same in udder circumference values (31.99 and 32.34 cm) before milking, while non-wattled does mated with non-wattled bucks (T_1) had significantly ($p<0.05$) lower values (29.34 cm). Does in T_3 (29.22 cm) had statistically ($p<0.05$) higher udder circumference after milking than those in other treatments. Does in T_1, T_2 and T_3 had statistically similar ($p>0.05$) values (8.40, 9.13 and 8.53 cm) ($p<0.05$) in the distance between teat before milking and differs significantly ($p<0.05$) from does in T_4 (7.36). After milking, does in T_3 (8.63) had the largest ($p<0.05$) distance between teats compared to does in other treatments. Does in T_1 (3.03) had the highest ($p<0.05$) values in teat length after milking while does in T_2, T_3 and T_4 (2.57, 2.63 and 2.44 cm) had similar values ($p>0.05$). Does in T_2, T_3 and T_4 had (141.64, 139.28 and 154.53 ml) and (283.28, 278.56 and 309.06 ml respectively) similar ($p<0.05$) and higher total quantity of milk yield and average daily milk yield than those in T_1 (120.13 ml and 190.25 ml respectively). Does in T_3 had significantly ($p<0.05$) higher first test day milk yield than does in T_1, T_2 and T_4. Does in T_3 and T_4 had significantly ($p>0.05$) higher peak yield values (440 ml and 520 ml) over does in T_1 (210 ml and T_2 (298.33 ml), respectively. Does in T_4 recorded the highest ($p<0.05$) total milk yield (3709.00 ml), followed by does in T_2 (3399.00 ml), T_3 (3343.00 ml) and T_1 (2283), respectively.

Journal of Arid Agriculture. 2025, Vol. 26 (1): 16 - 22

Table 3 shows the effect of wattle on the mean proximate composition, vitamin and mineral content of the milk samples of Red Sokoto does reared semi intensively. The Table shows no significant ($p>0.05$) difference in the mean proximate components of milk except for moisture, fat, nitrogen free extract and the metabolizable energy. The milk samples in T_1 and T_4 had higher ($p<0.05$) moisture content (85.78 and 85.83 %) than T_2 and T_3 (83.84 and 84.21 %). For values of fat, nitrogen free extract and metabolizable energy composition of the milk, does in T_2 (4.32 %, 16.17 % and 125.69 kcal) and T_3 (5.23 %, 15.65 % and 136.75 Kcal) had statistically similar values ($p>0.05$) but higher than T_1 and T_4. The Table showed a significant ($p<0.05$) difference in the vitamin B content of the milk while there was no significant ($p>0.05$) difference in the vitamins A and C content of the milk. The milk samples from does in T_1, T_2 and T_3 had statistically similar ($p>0.05$) values of vitamin B content while vitamin B content of the milk from does in T_4 was loweest ($p<0.05$). The Table revealed a significant ($p<0.05$) difference in magnesium, iron and calcium content of milk only. Other minerals showed no significant ($p>0.05$) difference. Magnesium was the least in the milk samples obtained in T_4 does.

Table 2 Effect of wattle on mean udder measurements and milk yield of Red Sokoto does kept semi intensively

Parameters (cm)	T_1	T_2	T_3	T_4	SEM
Udder circumference before milking	29.34^{b}	31.99^{a}	32.34^{a}	30.90^{ab}	0.37
Udder circumference after milking	25.74^{c}	28.00^{ab}	29.22^{a}	26.74^{bc}	0.38
Distance between teat before milking	8.40^{a}	9.13^{a}	8.53^{a}	7.36^{b}	0.17
Distance between teat after milking	7.34^{bc}	8.13^{ab}	8.63^{a}	6.85^{c}	0.17
Teat length before milking	3.28	3.11	2.52	2.91	0.16
Teat length after milking	3.03^{a}	2.57^{b}	2.63^{b}	2.44^{b}	0.06
Quantity of milk yield (ml)	120.13^{b}	141.64^{a}	139.28^{a}	154.53^{a}	5.06
Average daily milk yield (ml)	190.25^{b}	283.28^{a}	278.56^{a}	309.06^{a}	13.84
First test day milk yield (ml)	176.67^{b}	216.67^{b}	440.00^{a}	270.00^{b}	14.07
Peak yield (ml)	210.00^{b}	298.33^{b}	440.00^{a}	520.00^{a}	14.93
Last test day milk yield (ml)	200.00	233.33	230.00	260.00	15.92
Total milk yield (ml)	2283^{d}	3399^{b}	3343^{c}	3709^{a}	16.07

^{abcd} Means within a row having different superscripts differed significantly ($p<0.05$);
T_1= non-wattled does mated with non-wattled bucks; **T_2** = non-wattled does mated with wattled bucks; **T_3**= Wattled does mated with non-wattled buck; **T_4**= Wattled does mated with wattled bucks. **SEM=** Standard error of mean

Table 3 Effect of wattle on the mean proximate composition, vitamin and mineral content of the milk of Red Sokoto does reared semi intensively

Parameters	T_1	T_2	T_3	T_4	SEM
Proximate composition of milk					
Moisture (%)	85.78^{a}	83.84^{b}	84.21^{b}	85.83^{a}	0.32
Crude protein (%)	5.71	5.54	6.81	5.43	0.33
Crude fibre (%)	0.00	0.00	0.00	0.00	0.00
Ash (%)	0.76	0.77	0.76	0.82	0.02
Fat (%)	3.74^{b}	4.32^{ab}	5.23^{a}	3.73^{b}	0.25
Nitrogen free extract (%)	14.21^{b}	16.17^{a}	15.65^{ab}	14.08^{c}	0.32
Carbohydrate (%)	3.86	5.55	3.36	4.11	0.52
Metabolizable energy (Kcal)	113.33^{b}	125.69^{ab}	136.75^{a}	119.29^{b}	3.33
Dry matter (%)	14.22	16.16	15.79	14.17	0.22
Vitamins content of milk					
Vitamin A (u/I)	34.03	33.26	35.05	32.13	0.67
Vitamin B (mg/g)	56.55^{ab}	56.24^{ab}	56.91^{a}	55.46^{b}	0.23
Vitamin C (mg/100g)	3.23	3.12	3.49	2.78	0.13
Mineral content of milk (Mg/100g)					
Sodium	12.87	13.39	12.20	12.00	0.60
Potassium	138.30	131.47	131.74	160.60	6.03
Phosphorus	0.00	0.00	0.00	0.00	0.00
Magnesium	9.70^{a}	10.38^{a}	10.26^{a}	7.41^{b}	0.38
Iron	0.08^{b}	0.18^{ab}	0.24^{ab}	0.34^{a}	0.03
Zinc	0.00	0.00	0.00	0.00	0.00
Calcium	119.70^{ab}	123.82^{a}	127.52^{a}	109.79^{b}	2.21

^{abcd} Means within a row having different superscripts differed significantly ($p<0.05$);

T_1= Non-wattled does mated with non-wattled bucks; **T_2** = Non-wattled does mated with wattled bucks; **T_3**= Wattled does mated with non-wattled buck; T_4= Wattled does mated with wattled bucks. **SEM=** Standard error of mean

DISCUSSIONS

The result obtained for the average udder circumference before and after milking in relation to the milk produced in non-wattled does mated with wattled bucks (T_2), wattled does mated with non wattled bucks (T_3) and wattled does mated with wattled bucks (T_4) agrees with the findings of Sam *et al.* (2017) who observed a positive correlation between udder conformation traits (udder height and udder circumference) and milk yield (initial yield, average daily yield, peak yield, total yield and lactation length) (Table 2). This result therefore confirms that increase in udder size would increase milk yield. The higher milk yield obtained in does with wattle and does mated with wattle agrees with the finding of Shongjia *et al.* (1992) who observed significantly ($p<0.05$) higher milk yield in wattled Saanen does. The result is not in line with the works of Stutz (2016) who found no meaningful contribution of wattle in dairy goats.

The result obtained in wattled does mated with wattled bucks (T_4) in relation to its udder circumference and distance between teat with the milk produced could however be attributed to the higher litter or twins obtained in the treatment. This agrees with the findings of Ijomanta (2012) that milk yield increase with increase in litter size. The distance between teat for does in non-wattled does mated with wattled bucks (T_2) and wattled does mated with non-wattled bucks (T_3) were wider which may be the reason why the milk yield in these treatments were among the highest. Upadhyay *et al*. (2014) observed that correlation between teat parameters (except for teat height from ground) and milk yield were significant and positive However, data obtained from this work suggest that teat length both before and after milking may have negative influence on milk yield as non-wattled does mated with non-wttled bucks (T_1), which had the longest teat length, had the least milk production. wattled does mated with wattled bucks (T_4) had the highest total milk yield of 3709.00 ml and this could be because of the quantity of milk obtained in the peak yield. The small udder circumference (before and after milking), longer teat length (before and after milking) and poor milk yield obtained in non-wattled does mated with non-wattled bucks (T_1) could be because of the pendulous udders of the does in the treatment. This result is in agreement with the findings of Upadhyay *et al*. (2014) who obtained a similar result and attributed it to the pendulous nature of the udders, which was discovered to be inversely proportional to milk yield and therefore, should be considered as a serious factor for disqualification of goats for dairying.

The average moisture content of milk samples obtained from does in T_1 and T_4 (Table 3) were higher during the twelve weeks of the experiment which also affected the availability of other nutrient (fat, nitrogen free extract, and metabolizable energy). This result agrees with Dairy Foods (2018) that moisture content dramatically affect flavour, texture, physical and chemical properties of food as well as sensory perception of food. Wattled does mated with wattled bucks in T_4 had the lowest vitamin B content.

Vitamin B is normally associated with cell health, growth of red blood cells, energy levels, good eye sight, healthy brain function, good digestion, healthy appetite, proper nerve function, proper hormones and cholesterol production, cardiovascular health and muscle tone (Cronkleton, 2018 ;Mayo Clinic 2018).

Milk samples of does in T_1, T_2 and T_3 had high magnesium content. The higher magnesium content in the three treatments could be because of the lower moisture in the milk collected from the does. Magnesium is a mineral that is crucial to the body's function. Magnesium helps keep blood pressure normal, bones strong, and the heart rhythm steady (WebMD, 2018).

Milk samples from does in T_4 had the highest iron content compared to T_1. One of the main roles of iron is to help red blood cells transport oxygen to all parts of the body. Iron also plays an important role in specific processes within the cell that produce energy for the body. It is for this reason that one of the first symptoms of low body iron stores is tiredness and fatigue (Nestle, 2018).

Milk samples collected from non-wattled does mated with wattled bucks (T_2) and wattled does mated with non-wattled bucks (T_3) had higher calcium than wattled does mated to wattled bucks (T_4). Calcium is an essential mineral needed for bone health (Bayer, 2018). Calcium performs two crucial functions in the body: regulating certain body processes and building of bones and teeth (Preserved Articles, 2018; Nemours Foundation, 2018).

Journal of Arid Agriculture. 2025, Vol. 26 (1): 16 - 22

CONCLUSIONS

Wattle had significant ($p<0.05$) influence on the milk and udder parameters examined. Crosses between the wattled and the non-wattled had the highest in terms of udder circumference before and after milking, in quantity of milk and average daily milking. Wattled does in T_3 and T_4 produced the highest peak yield. Wattled does mated with wattled bucks (T_4) had the highest total milk yield.

RECOMMENDATION

i Attention should be focused on the mating between the wattled and the non-wattled strains of Red Sokoto as it gave best result in most parameters examined. Therefore, research studies focused on body weight and morphometric parameters, haematology and serum biochemistry, reproduction and milk production should be carried out in crosses of Red Sokoto breeds. This may bring about the needed improvement in the areas listed above.

ii efforts must be made to preserve the wattle gene to avoid the goats carrying the gene from going to extinction.

REFERENCES

Ademosun A. A. (1994). Constraints and prospects for small ruminant research and development in Africa. In small Ruminant Research and development in Africa proceedings of the 2nd Biennial conference of the African small Ruminant Research network, Arcc, Arusha, Tanzania, December 7th-11th, 1992:1-6

Akpa, G.N, Duru, S. and Amos. T. T (1998a). Influence of strain and sex on estimation of withinage-group body weight of Nigerian Maradi goats from their linear body measurement. *Tropical Agriculture (Trinidad)*, 74, 462-467.

Ambulance and Health (2018). The six important roles of vitamin C. www.abundancehealth.co.uk. Retrieved 15 January, 2019.

Ayadi, M., Abdelkarim, M. M., Riyadh, S.A. and Mohammed, A.A. (2014). Evolution of udder morphology, alveolar and cisternal milk compartment during lactation and their relationship with milk yield in Najdi sheep. *Spanish Journal of Agricultural Reseach*, 12(4), 1061-1070.

Bayer (2018) Importance of Calcium — Go Deeper for Bone Health. http://www.bayer.us/en/csr-and-sustainability/transparency-in-supply-chains/. Retrieved 12 December, 2018

Bencini, R., Knight, T. W. and Hartmann, P. E. (2003). Secretion of milk and milk component in sheep. *Australian Journal of Experimental Agriculture*, 43, 524- 532.

Cronkleton, E. (2018). Why Is Vitamin B Complex Important, and Where Do I Get It? https://www.healthline.com/medical-team. Retrieved 2 April 2018.

Dairy Foods (2018). Moisture, Ash Testing in Food Processing. Pp. 1-21

Federal University of Technology Minna (2018). Student Hand book. Produced by Office of the Vice Chancellor Student Affairs Division. P1.

https://www.dairyfoods.com/directories/7376-dairy-plants-USA. Retrieved 30 June 2010

Ijomanta, O. E (2012). Genetic profile of morphological traits and their association with production capacity of the Red Sokoto goat in Katsina State of Nigeria. M.sc Thesis from Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.

Institute of Medicine (1997). Food and Nutrition Board. Dietary Reference Intakes: Calcium, Phosphorus, Magnesium, Vitamin D and Fluoride. Washington, DC: National Academy Press.

Isaac, N. (2017) Are there any adverse effects to mixing milk with water**?** https://www.quora.com/MTE5OTI1OTI5NzIyOTQ5NzU5M3wyMTExMDYyMzM0NzMxNjd8MA**/luno-124. Retreived 15 May 2017

Kilekoung, J. P. M., Julius, A. N., Houinga, D. and Pagnah A. (2017). Effects of body conformation and udder morphology on milk yield of Zebu cows in North region of Cameroon. *Veterinary World*, 10(8): 901-905.

Kukovics, S., Andras, M., Maria, A., Timea, N. and Istvan K. (2006). Effect of udder traits on milk yield of sheep. *Archieves of Animal Breeding*, 49 (2), 165-175.

Mayo Clinic (2018). High-density lipoprotein. https://www.mayoclinic.org/diseases-conditions/high-blood-cholesterol/in-depth/hdl-cholesterol/art-20046388. October 24, 2018.

Merkhan, K. Y. and Alkass, J. E. (2011). Influence of udder and teat size on milk yield in Black and Meriz goats. *Reseach Opinions in Animal Veterinary Science*, 1(9), 601-605.

Moufida, A. (2014). Caractéristiques AnatomoPhysiologiques de la Glande Mammaire Chez La Chamelle en Tunisie et son Aptitude à la Mécanisation de la Traite. Thèse de Docteur en Sciences Agronomiques/Sciences

de la Vie, Institut National Agronomique de Tunisie, Spécialité Sciences de Production *Animale/Biologie et Agronomie*, p190.

Nemours Foundation (2018). Calcium. https://kidshealth.org/en/teens/calcium.html.

Nestle (2018). Importance of Iron. https://www.nestle.co.nz/nhw/nutritionlifestage nutrition pregnancy/ importance of iron

Osuhor C. U, Alawa J. P. and Akpa, G. N. (2002). Research note: manure production by goat grazing native pasture in Nigeria. *Tropical Grasslands*, 36, 123-125.

Ozoje, M.O., and Kadir, O.A. (2001). Effects of coat colour and wattle genes on body measurement traits in the West African Dwarf Sheep. Tropical Agriclture (Trinidad) 78: 118 – 122.

Patel, Y. G., Trivedi, M. M., Rajpura, R. M., Savaliya, F. P. & Monika, P. (2016). Udder and teat measurements and their relation with milk production in crossbred cows. *International Journal of Environmental. Science and Technology*, 5(5), 3048-3054.

Preserved Article (2018). What is the importance of calcium in human body? Retrieved from http://www.preservearticles.com/articles/what-is-the-importance-of-calcium-in-human-body/5802.

Sabbioni, A., Beretti, V., Paini, V. & Superchi,P. (2011). Occurrence and inheritance of wattles and effects of genotype at wattle locuson Gompertz growth curve parameters in "Nero di Parma" pigs.Livestock Science. 137, 226–230.

Sam, M., Akpa, G. N. & Alphonsus, C. (2017). Factors Influencing Udder and Milk Yield Characteristics of Indigenous Goats in North - West Nigeria. *Asian Research Journal of Agriculture*, 3(2), 1-9.

SAS (2000). Statistical Analysis System. SAS Institute Inc, SAS Campus Drive. Carry, North Carolina 27513, U.S.A.

Safefood 360 (2014). Water Activity (a_w) in Foods. Part of Our Professional Whitepapers Series. Pp 1-7. https://safefood360.com/resources/Water-Activity.pdf.

Shongjia, L., Xiangmo, L., Gangyl, X. and Shenov, C. (1992). Relationship between physical traits, litter size and milk yield in Saanen, Guanzhong and Crossbred goats. *Proceedings of the 5th International Conference of Goats.* Pp. 83 in New Delhi.

Siddik, K., Kor, A., Karaca, S. & Mertagioglu, H. (2005). A study of relationships between milk yield and some udder traits by using of path analysis in Akkeci goats. *Journal of Animal Veterinary Advances*, 4, 547-550.

Spritzler, F. (2018). Ten Evidence-Based Health Benefits of Magnesium. Newsletter. Pp 1- 27. Retrieved from https://www.healthline.com/health/about-us#link-an_page

Stultz, J. (2016). What are wattles? *Dairy Goat Journal. Pp 1-3.* March 14 2019 *https://backyardgoats.iamcountryside.com/ownership/all-about-goat-wattles/*

Upadhyay, D., Patel, B. H. M., Kerketta, S., Kaswan, S., Sahu, S., Bharat, B. and Dutt T. (2014) Morphology and its relationship with production parameters in local goats of Rohilkhand region of India. *Indian Journal Animal of Research*, 48(6), 615-619.

University of Califonia San Fransico Medical Center (2018). Hemoglobin and functions of Iron.

WebMD Medical (2018). High Density Lipo protein. Reference Reviewed by Suzanne R. Steinbaum, MD on July 17, 2018

Zelman, K. M. (2018). Benefits of vitamin C. From web md archives. www.webmd.com.