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Influence of wattle on udder measurements and milk yield of Red Sokoto (*Maradi*) does raised semi-intensively in Minna, Niger state, Nigeria.

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Target Audience: Animal Scientists, Breeders, Policy makers

Abstract

A study on the Influence of wattle in Red Sokoto (Maradi) goats on udder measurements, colostrum/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. After the experiment, it was observed that crosses between the wattle and the non-wattled had the highest ($p<0.05$) udder circumference before and after milking, quantity of milk and average daily milking. Wattled does crossed with non-wattled bucks in T_3 and Wattled does crossed with wattled bucks in T_4) produced the highest ($p<0.05$) peak yield. Wattled does mated with wattled bucks (T_4) had the highest ($p<0.05$) total milk yield. Wattled does mated with wattled bucks (T_4) had the ($p<0.05$) highest moisture content in colostrum sample which reduced the availability of other minerals. Non-wattled does mated with non-wattled bucks (T_1) and wattled does mated with wattled bucks (T_4) 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 into extinction.

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

Description of Problem

The Red Sokoto goat is the most predominant goat breed and it accounts for about 70 % of Nigeria's total goat population, which have been estimated at 17.5 million (1). It is commonly found among the agro pastoralist, mainly within the northern sub humid and semiarid zone of the country (2). The breed is predominantly reddish brown in colour and is found in the savannah zone of Nigeria (8°N – 11°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 (3).The skin of Red Sokoto goat is reputed to be of high quality; therefore, it is used in the leather industry, both locally and internationally (2). The Red Sokoto breed have some unique features among which includes the development of wattles.

Wattles are little thumb-shaped that dangles on the ventral throat of some domestic goats. Wattle have been regarded as a structural outgrowth in the body of animals whose function is still under debate (4) 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 (5) 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 colostrum/milk composition and udder parameters of Red Sokoto does.

Materials and Methods

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^o 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 (6).

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 avoid the purchase of pregnant does while males of about one and half to two years were purchased to ensure effective breeding (the ages of the goats were determined by dental examination). The animals were sourced from within 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 weeks (this further allowed more time for sexual maturity in the does). During acclimatization, the goats were administered with Ivomectin®; a broad spectrum anti parasitic drug, to remove both internal and external parasites. Vaccination against peste des petits ruminants (PPR) was done using PPR-VAC®. Broad spectrum anti-biotic (20 % oxytetracycline: 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 released 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 had 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 separated from the bucks and raised semi intensively while the bucks were confined before mating (to prevent unwanted breeding). The animals were allowed to graze in the day time and housed later in the evening after grazing.

Table 1. Proximate composition of the experimental feeds

Parameters	Yam peel	Maize offal	Beans husk	Sorghum chaff
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 samples were 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 (7). Milk yields was measured using Pyrex measuring cylinder of 2 litre capacity. The quantity of milk collected at each milking was recorded. Other parameters recorded weekly includes:

Udder circumference (cm): This was done using cloth 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 was 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.

Data was also collected on the following:

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 (8). 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 measured 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.

The effect of wattle on the proximate composition, vitamin and mineral content of colostrum of Red Sokoto does reared semi intensively and presented in Table 3. revealed a significant ($p<0.05$) difference in the moisture content, nitrogen free extract and the metabolizable energy of the colostrum. The colostrum of does in T_4 had the highest ($p<0.05$) moisture content (88.18 %) while does in T_1, T_2 and T_3 had lower and similar ($p>0.05$) moisture in their colostrum (85.5 %, 83.566 % and 83.25 %). The nitrogen free extract in the colostrum of does in T_1, T_2 and T_3 (14.44 %, 16.44 % and 16.75 %) were statistically similar ($p>0.05$) but higher ($p<0.05$) than does in T_4 (11.82 %). The metabolizable energy in the colostrum of does in T_3 (133.25 Kcal) was higher ($p<0.05$) than T_4 (88.40 Kcal) but statistically similar to T_1 and T_2. The Table also revealed a significant ($p<0.05$)

difference only in the vitamin C content of the colostrum. Vitamins A and B showed no significant ($p>0.05$) difference. Colostrum from does in T_3 (3.55 mg/100g) had higher ($p<0.05$) vitamin C content over T_4 (2.00 mg/100g). The Table showed no significant ($p>0.05$) difference in the entire mineral content (sodium, potassium, phosphorus, magnesium, iron, zinc and calcium) evaluated for colostrum.

Table 4 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 lowest ($p<0.05$). 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 proximate composition, vitamin and mineral content of colostrum of Red Sokoto does reared semi intensively

Parameters	T_1	T_2	T_3	T_4	SEM
Proximate composition of colostrum					
Moisture (%)	85.56^{b}	83.56^{b}	83.25^{b}	88.18^{a}	0.68
Crude protein (%)	5.01	5.21	6.82	3.45	0.58
Crude fibre (%)	0.00	0.00	0.00	0.00	0.00
Ash (%)	0.72	0.85	0.72	0.82	0.03
Fat (%)	3.29	3.58	4.33	3.04	0.29
Nitrogen free extract (%)	14.44^{a}	16.44^{a}	16.75^{a}	11.82^{b}	0.68
Carbohydrate (%)	4.94	6.80	4.88	4.51	0.70
Metabolizable energy (Kcal)	107.42^{ab}	118.79^{ab}	133.25^{a}	88.40^{b}	6.78
Dry matter (%)	14.44	16.44	16.75	11.82	
Vitamin content					
Vitamin A (u/I)	33.08	31.82	35.26	29.11	1.19
Vitamin B (mg/g)	56.17	55.76	57.00	55.11	0.61
Vitamin C (mg/100g)	2.63^{ab}	2.92^{ab}	3.55^{a}	2.00^{b}	0.23
Mineral content (Mg/100g)					
Sodium	12.10	10.60	12.90	13.74	0.87
Potassium	173.50	169.00	198.50	175.34	5.60
Phosphorus	0.00	0.00	0.00	0.00	0.00
Magnesium	11.61	13.80	10.75	7.78	1.31
Iron	0.10	0.26	0.09	0.20	0.04
Zinc	0.00	0.00	0.00	0.00	0.00
Calcium	139.50	131.00	133.00	111.66	6.71

^{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 4: 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/l)	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 T_2 (non-wattled does mated with wattled bucks), T_3 (wattled does mated with non-wattled bucks) and T_4 (wattled does mated with wattled bucks) agrees with the findings of (9) who observed a positive correlation between udder conformation traits and milk yield. This result also agrees with the findings of (10, 11 and 12) who observed positive relationship between udder conformation traits (udder height and udder circumference) and milk yield characteristics (initial yield, average daily yield, peak yield, total yield and lactation length). Strong relationship between udder size and milk yield have also been reported in sheep (13) and in cattle (14). This result therefore confirms that increase in udder size would increase milk yield. The higher milk yield obtained in does with wattle and non-wattled does mated with wattle buck, agrees with the finding of (15) who observed significantly ($p<0.05$) higher milk yield in wattled Saanen does. The result disagrees with the works of (16) who found no meaningful contribution of wattle in dairy goats. The result obtained in T_4 (wattled does mated with wattled bucks) 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 (17) that milk yield increase with increase in litter size. The distance between teat for does in T_2 were wider which may be the reason why the milk yield in these treatments were among the highest. (18) observed that correlation between teat parameters (except for teat height from ground) and milk yield (average daily milk yield and total milk yield) were significant and positive. (19) also reported that daily milk production is positively correlated to distance between teats. (20) observed a positive significant correlation between teat circumference and daily milk yield. Presently, materials linking teat length to milk production are scarce. However, data obtained from this work suggest that teat length both before and after milking may have negative influence on milk yield as does in T_1 (non-wattled does mated with non-wattled bucks), which had the longest teat length, had the least milk production. T_4 (wattled does mated with wattled bucks) 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 T_1 could be because of the pendulous udders of the does in the treatment. This result is in agreement with the findings of (18) 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 colostrum samples in T_4 had higher moisture content than any other treatments, which directly affected the availability of other nutrients in the milk including; nitrogen free extract and metabolizable energy. The crude protein, fat and carbohydrates though not showing any significant difference, were also lower than amounts found in the other treatments. This result is in line with the reports of (21) who stated that increased water content in milk reduces the protein and fat content in the milk. (22) reported that moisture content dramatically affect flavour, texture, physical and chemical properties of food as well as sensory perception of food. The moisture content is also an important component in determining the shelf life of food products. (23) observed that high moisture content in food encourages microbial growth, and supports chemical and enzymatic reactions as well as food spoilage processes. Other treatments were also affected by water content in the colostrum as the lower moisture contents translated into a better milk in terms of higher nitrogen free extract, metabolizable energy, crude protein and fat. Wattled does mated with bucks without wattle (T_3) had higher vitamin C content in their colostrum compared to wattled does mated to wattled bucks (T_4). Vitamin C is regarded as one of the safest and most effective nutrients in milk. Its benefits include: protection against cardiovascular diseases, immune system deficiencies, eye disease and skin wrinkling and prenatal health problems (24). Higher levels of vitamin C in blood may be the ideal nutrition marker for overall health (24). According to (25), vitamin C is essential for the synthesis and maintenance of collagen (the most abundant protein in the human body) and basement membrane synthesis (thin sticky layer that support the epithelial cell layer). Vitamin C serve as an essential co-factor for the synthesis of carnitine (an amino acid that is necessary for the transport of fatty acids into mitochondria). Vitamin C is directly involved in the synthesis of neurotransmitter (biological molecules that facilitate the electrical flow between neurons and nerve cells in the body and in the brain). Vitamin C promotes calcium incorporation into bone tissue, is responsible for immune system function and maintenance, acts a powerful antioxidant that neutralizes harmful free radicals and aid in neutralizing pollutants and toxins. Vitamin C is also able to generate other antioxidants such as vitamin E. Vitamin C in combination with zinc help in the healing of wound (24). Vitamin C contributes to the health of the teeth and gum, improves the absorption of iron, is needed for the metabolism of bile acids, which may have implication on blood cholesterol level and gall stone. Vitamin C also plays important role in the synthesis of several important peptide hormones, neurotransmitters and carnitine (24).

The average moisture content of milk samples obtained from does in T_1 (non-wattled does mated with non-wattled bucks) and T_4 (wattled does mated with wattled bucks) 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 (22) that moisture content dramatically affect flavour, texture, physical and chemical properties of food as well as sensory perception of food. The higher moisture content that directly affected the availability of other nutrients in T_4 could also be one of the factors that contributed to lower body weight and body measurements of kids in the two treatments (26). 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 (27). According to the (26), vitamin B_{12} plays a significant role in nerve function, the formation of red blood cells, and the production of DNA. Vitamin B_6 (pyridoxine) is vital for normal brain development and for keeping the immune and nervous system working properly, and help reduce risk of heart disease. Folate (vitamin B_9) is in the forefront of mood management, prevent serious birth defects of the brain and spine such as spina bifida in children. B vitamins are tied to lower stroke risk. Vitamin B_1 is important for preventing beriberi. Riboflavin (Vitamin B_2) boosts the immune system. Vitamin B_3 (Niacin) breaks down food into energy. Vitamin B_5 is good for healthy hormones (26). Milk samples of does in T_1 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 (28). Magnesium is involved in hundreds of biochemical reactions in the body; it boosts exercise performance and fights depression. Magnesium has benefits against type-2-diabetes, helps to lower blood pressure; it has anti-inflammatory benefits and prevent migraines (29). Magnesium is a cofactor in more than 300 enzyme systems that regulate diverse biochemical reactions in the body, including protein synthesis, muscle and nerve function, blood glucose control, and blood pressure regulation (30). Magnesium is required for energy production, oxidative phosphorylation, and glycolysis. It contributes to the structural development of bone and is required for the synthesis of DNA, RNA, and the antioxidant glutathione. Magnesium also plays a role in the active transport of calcium and potassium ions across cell membranes; a process that is important to nerve impulse conduction, muscle contraction, and normal heart rhythm. Milk samples from does in T_4 (wattled does mated with wattled bucks) had the highest iron content compared to non-wattled does mated with non-wattled bucks (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 (31). Iron is an essential element for blood production. About 6 % of body iron is a component of certain proteins, and it is essential for respiration and energy metabolism, and also as a component of enzymes involved in the synthesis of collagen and some neurotransmitters. Iron is also needed for proper immune function (32). 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 (33). Calcium performs two crucial functions in the body: regulating certain body processes and building of bones and teeth (34; 35). Calcium helps in building strong bones and teeth in sending and receiving nerve signals in clotting blood, releasing hormones and other chemicals, squeezing and relaxing muscles and keeping a normal heartbeat (34).

Conclusion and Applications

1. The study concludes that wattle had significant ($p<0.05$) influence on the milk and udder parameters examined.
2. Reciprocal crosses between the wattled and the non-wattled had the highest udder circumference before and after milking, quantity of milk and average daily milking.
2. Wattled does mated with wattled bucks (T_4) had the highest total milk yield.

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