EFFECT OF MUCUNA (*Mucuna pruriens)* ON SPERMIOGRAMS OF WEST AFRICAN DWARF BUCKS

[EFECTO DE MUCUNA (*Mucuna pruriens*) EN ESPERMIOGRAMAS DE MACHOS CAPRINOS DE LA RAZA WEST AFRICAN DWARF]

James O. Daramola[1]*, John A. Abiona[1]., Olusiji F. Smith[1], Olubukola A. Isah[2], Olusiji S. Sowande[3], Moshood O. Olaniyi[4], Jimoh A. Olanite[5]

[1]*Department of Animal Physiology, Email: daramolajames2003@yahoo.com; Tel:+2348051099403*
[2]*Department of Animal Nutrition*
[3]*Department of Animal Production*
[4]*College of Veterinary Medicine*
[5]*Department of Pasture & Range Management*
Federal University of Agriculture Abeokuta, PMB 2240, Nigeria
**Corresponding author*

SUMMARY

The study was carried out to investigate the potential effect of *Mucuna pruriens* seed powder on spermiograms of West African Dwarf bucks (WAD). Twenty bucks were randomly assigned to five treatments consisting of four animals each receiving 0, 25, 50, 75, 100mg/Bw of *Mucuna pruriens* seed powder administered via oral route for 30 days consecutively. Following treatment, spermiograms of the animals were determined. The results showed that exposure of bucks to *Mucuna pruriens* powder led to a significant increase in weight gain, scrotal width, scrotal circumference, testicular weight, gonadosomatic index, sperm motility and testicular parenchyma of animals compared to the control and the improvement in these parameters was much pronounced in bucks that received 75mg *Mucuna pruriens* seed powder ($P<0.05$). Higher ($P<0.05$) sperm concentration was observed in 100mg inclusion of *Mucuna pruriens* seed powder compared to other treatments. The results showed a decline ($P<0.05$) in the level of testosterone with increasing level of *Mucuna pruriens* seed powder administration. The findings showed that oral administration of *Mucuna pruriens* seed powder to the bucks for 30 days resulted in improved testicular measurements and sperm quality without any adverse effect on structure of reproductive physiology of the bucks.

Keywords: Bucks; *Mucuna pruriens;* spermiograms*;* sperm quality.

RESUMEN

El estudio se llevó a cabo para investigar el efecto potencial de la harina del frijol *Mucuna pruriens* en el espermiograma de machos caprinos de la raza West African Dwarf (WAD). Veinte animales fueron asignados al azar a cinco tratamientos (cuatro animales cada uno) recibiendo 0, 25, 50, 75, 100mg/kg PV de *Mucuna pruriens* administrado por vía oral, durante 30 días consecutivos. Después del tratamiento, se determinaron los espermiogramas de los animales. Los resultados mostraron que la exposición de los animales a la harina de *Mucuna pruriens* condujo a un aumento significativo en el peso, anchura escrotal, circunferencia escrotal, peso testicular, índice gonadosomático, la motilidad del esperma y el parénquima testicular de los animales en comparación con el control y la mejora de estos parámetros fue más pronunciado en los animales que recibieron 75g *Mucuna pruriens* ($P<0,05$). Se observó una mayor concentración de espermatozoides ($P<0,05$) en la inclusión de 100mg *Mucuna pruriens* en comparación con otros tratamientos. Los resultados mostraron una disminución ($P < 0.05$) en el nivel de testosterona con el aumento de nivel de la administración de *Mucuna pruriens*. Los resultados mostraron que la administración oral de *Mucuna pruriens* a los animales durante 30 días dio lugar a la mejora de las mediciones testiculares y la calidad del esperma y sin ningún efecto adverso en la estructura de la fisiología reproductiva de los machos.

Palabras clave: Machos cabríos; *Mucuna pruriens*; espermiogramas; la calidad del esperma.

INTRODUCTION

The Problem of idiopathic male infertility is a major constraint in livestock production. Restriction is being imposed on the use of synthetic hormones and antioxidants because of their carcinogenicity (Osei-bonsu, 1998), hence the need for natural antioxidants therefore become imperative and desirable. In the vast resource of phytoproducts in South Western Nigeria, there are various plants that are claimed to contain antioxidants and phytohormones. *Mucuna pruriens* is a tropical legume known as velvet bean, found in Africa, India and the Caribbean. *Mucuna pruriens* is indigenous to and commonly found in South Western Nigeria. Roots, leaves and seeds of the plant are commonly used in the treatment of impotence, snake bite, diabetes, cancer and Parkinsonism (Alo *et al*. 2012). *Mucuna pruriens* has also shown to exhibit neuroprotective effect by increase brain mitochondrial complex-I activity and significantly restoring dopamine and norepinephrine levels in Parkinsonism animal model (Manyam *et al*. 2004). Seeds of *Mucuna pruriens* possess antioxidant, neuroprotective activities and bioactive substances (Sharma *et al*. 1978; Misra and Wagner, 2007). With the increasing acceptance of natural source of substances as an alternative form of health care (Sharma *et al*. 1978; Misra *et al*. 2007), the screening of medicinal plants for active compounds has become very important because these may serve as promising sources of novel hormone and antioxidant prototypes. Presently, no available information in literarure on the effect of the *Mucuna pruriens* on spermiograms of West African Dwarf bucks. The research was therefore conducted to investigate the potential effect of *Mucuna pruriens* seed powder on spermiograms of West African Dwarf bucks.

MATERIALS AND METHODS

The experiment was carried out at the Small Ruminant Unit, Federal University of Agriculture, Abeokuta, located in the tropical rain forest zone of Nigeria within 7^0 10'N and 3^0 2'E in line with the regulations of the Institute of Food Security, Environmental Resources and Agriculture Research (IFSERAR) of Federal University of Agriculture Abeokuta, Nigeria. Twenty (20) West Africa Dwarf bucks of ages ranging between 8-12 months and weighting 8.355 $\pm$ 0.8674kg were used. The bucks were kept and maintained under semi intensive method and uniform nutritional regime. The animals were fed with concentrate at 300g/body weight (Bw) while *Panicum maximum* and water was given to them *ad libitum*. The animals were divided into 5 groups of 4 animals each and each group was randomly assigned to one of experimental treatments consisting of 0, 25, 50, 75, 100mg/BW of *Mucuna pruriens* seed powder administered via oral route to the animals for 30 days consecutively.

Data Collection

The body weight, scrotal circumference, scrotal length and scrotal width of the animals were recorded weekly for 65 days. The scrotal circumference was measured at the widest point of paired testes.Scrotal length was measured as the length of the testis when still in the scrotum while scrotal width was measured as the distance between the two sides of the broadest part of the scrotum using the thread and the thread measured on meter rule (Notter *et al*. 1985). Following castration under local anesthesia, testicular parameters (the testis weight, length, width of the testis and semen characteristics) and testicular histomorphometry were determined at the 65^{th} day of the trial. The paired testes were milked out, weighed and recorded in grams after the epididymis was trimmed off. Gonadosomatic index (%) was calculated (GSI = [testis weight/body weight] x 100). The length and width of each of the testis was measured using a pair of caliper. The volume of each testis was recorded using Archimedes' principle of water displacement by the amount of water displaced in a 500 cm^3 measuring cylinder filled with water at 300cm^3. The tunica albuginea (peeled-off of the testis) was weighed individually and recorded in grams. The testicular parenchyma was then calculated as the difference between the whole testis and weight of tunica albuginea, while the testicular index was calculated for each buck as testis length multiplied by testis width.

Progressive sperm motility, sperm concentration and morphological examinations were carried out in line with Bearden and Fuquay (1997). Progressive sperm motility was determined using a phase-contrast microscope (400 x magnifications). A drop of semen was placed on a microscopic slide and sperm cells moving straight forward over the microscopic field were recorded. For each sample, at least five microscopic fields were examined. The mean of the five successive evaluations was recorded as the final motility score. The concentration was determined by the use of an improved Neubauer haemocytometer. Morphological examination of the sperms was carried out and primary abnormalities of the sperm cells located in the head, midpiece and tail were observed under a microscope.

Statistical Analysis

Data obtained were subjected to analysis of variance in a completely randomized design and means separated by Duncan Multiple Range Test (Duncan, 1955) in SPSS version 16 using the following model:

$Y_{ijk}= \mu + A_i + L_j + \sum_{ijk}$
Where,
Y_{ijk}= Dependent variables
μ = Population mean
A_i= effect due to i^{th} *Mucuna pruriens* treatments
L_j = effect due to j^{th} level of inclusion, j = 0, 25, 50, 75, 100
$\sum_{ijk}$= Experimental error

RESULTS

The means of spermiograms, of bucks exposed to *Mucuna pruriens* seed powder are presented in Table 1. Exposure of bucks to *Mucuna pruriens* seed powder led to a significant increase in weight gain, scrotal width, scrotal circumference, testicular weight, gonadosomatic index and testicular parenchyma of animals compared to the control (P<0.05). The improvement in weight gain, testicular weight, testicular length, testicular width, tunica albuginea, testicular parenchyma and testicular index were much pronounced in bucks that received 75mg *Mucuna pruriens* seed powder while much pronounced improvement of gonadosomatic index were observed in bucks that received both 75mg and 100mg of *Mucuna pruriens* seed powder (P<0.05). Total testicular semen volume and total sperm cells followed similar pattern with much pronounced higher (P<0.05) values observed in 25mg and 50mg inclusion of *Mucuna pruriens* seed powder compared to other treatments.

The means values of sperm characteristics, testosterone and physic-clinical parameters of bucks exposed to *Mucuna pruriens* seed powder are presented in Table 2. The results showed that bucks treated with Mucuna pruriens seed powder had higher sperm motility compared to the control and the improvement was much pronounced in bucks that received both 75mg and 100mg of *Mucuna pruriens* seed powder (P<0.05). Treatment also led to maintenance of sperm abnormality at low level particularly at 75mg levels of inclusion. Higher (P<0.05) sperm concentration was observed in 100mg inclusion of *Mucuna pruriens* seed powder compared to other treatments. The results showed a decline (P<0.05) in the level of testosterone with increasing level of *Mucuna pruriens* seed powder administration. The results showed that rectal temperature and pulse rate were similar in the treated groups and the control.

Table1. Means (SEM) of spermiograms of bucks exposed to *Mucuna pruriens* seed powder

Parameter	0mg	25mg	50mg	75mg	100mg	SEM
Weight gain (g)	2.00^{e}	3.50^{c}	4.00^{b}	4.50^{a}	3.10^{d}	0.743
Change in scrotal width (cm)	0.13^{d}	0.73^{b}	0.45^{c}	0.98^{b}	1.87^{a}	0.760
Change in scrotal circumference (cm)	1.00^{d}	3.20^{c}	5.10^{b}	3.50^{c}	6.00^{a}	1.090
Total testicular weight (g)	69.80^{d}	80.30^{b}	73.90^{c}	88.20^{a}	71.90^{c}	12.90
Total testicular length (cm)	13.09^{b}	13.66^{b}	13.08^{b}	15.27^{a}	12.15^{b}	0.330
Total testicular width (cm)	3.25^{c}	3.67^{b}	3.09^{c}	5.08^{a}	3.23^{c}	3.230
Total testicular semen volume (ml)	4.05^{bc}	4.26^{a}	4.26^{a}	4.10^{b}	3.69^{c}	3.690
Gonadosomatic index (%)	0.72^{d}	0.82^{b}	0.75^{c}	0.90^{a}	0.81^{a}	0.810
Tunica albuginea (g)	2.02^{b}	2.13^{b}	2.15^{b}	2.95^{a}	1.84^{c}	0.173
Testicular parenchyma (g)	32.88^{d}	37.99^{b}	34.84^{c}	42.01^{a}	34.88^{c}	4.606
Testicular index (cm^2)	10.63^{b}	12.65^{ab}	10.12^{b}	16.06^{a}	9.83^{b}	1.492

^{abcd} Means within row with different superscripts differ significantly (P<0.05); SEM = Standard Error of Mean

Table 2. Means (SEM) of sperm characteristics, testosterone and physico-clinical parameters of bucks exposed to *Mucuna. Pruriens* seed powder

Parameter	0mg	25mg	50mg	75mg	100mg	SEM
Sperm motility (%)	70.00^{c}	87.00^{ab}	80.00^{b}	91.00^{a}	90.00^{a}	12.850
Sperm concentration ($x10^9$/ml)	0.19^{b}	0.19^{b}	0.19^{b}	0.18^{b}	0.21^{a}	3.700
% Abnormality	6.00^{a}	3.00^{b}	2.80^{b}	1.04^{d}	2.40^{c}	0.051
Total Sperm cells ($x10^9$/ml)	0.76^{bc}	0.81^{a}	0.81^{a}	0.74^{c}	0.78^{b}	3.695
Testosterone (ng/ml)	7.60^{a}	7.00^{a}	4.60^{b}	1.60^{c}	0.30^{d}	0.021
Rectal temperature (^{o}C)	39.90	39.50	39.40	39.40	39.30	0.100
Pulse rate (beat/minute)	69.50	66.40	63.80	65.50	66.30	2.620

^{abcd} Means within row with different superscripts differ significantly (P<0.05); SEM = Standard Error of Mean

DISCUSSION

Measurement of scrotal circumference and mean diameter of testis give good indication of semen production (Knight, 1977). The increase in scrotal and testicular measurements coupled with improved spermatozoa indices suggested viable spermatozoa per unit of testes and agrees with Orji and Steinbach (1976), Knight (1977) and Notter *et al.* (1985) that sperm production correlates highly with the testicular size. The increase in scrotal and testicular measurements without the incidence of any depressive effect on sperm characteristics coupled with comparative values of rectal temperature and pulse rate indicated that the treatment did not have any adverse effect on structure of the reproductive physiology of the animal. According to Ezekwe (1998), Hamilton and Stark (1997) and Perry and Petterson (2001), testes size is a good indicator of present and future sperm production. The improved scrotal and testicular indices in animals treated with *Mucuna pruriens* seed powder indicated its possible positive effect on the spermatogenic potential of the buck treated with this antioxidant-rich plant. *Mucuna pruriens* supplementation in infertile men has been associated with increased sperm count and motility (Shukla *et al*. 2009) indicative of its potential effect on male fertility (Shukla *et al*. 2010; Gupta, *et al*. 2011). The present results however contradicted the observation of Paul and Joseph (2001) that studied the effects of seeds of *Mucuna pruriens* on the gonads and sex accessory glands of male guinea-pigs and showed the presence of potential male antifertility agent in *Mucuna pruriens*.

Moreover, the decline in the level of testosterone with increasing level of *Mucuna pruriens* powder administration was in contrast to previous studies in men and rats. Testosterone level in the treated groups compared to control could probably be due to mechanism of action through levodopa content, in which the increase in serum dopamine antagonizes (works against) prolactin's suppressive effect on libido and testosterone (Shukla *et al*. 2009). Testosterone has been increased in infertile men without any impairment in seminal parameters following 5g of Mucuna Pruriens extract over 3 months (Shukla *et al.* 2009). Testosterone was also increased in the seminal experimental groups (those with low sperm motility or count), and to a more significant degree. Moreover, in rats with type II diabetes, increase in testosterone has been recorded with an oral dose of 200mg/kg bodyweight *Mucuna Pruriens* (Suresh and Prakash, 2010). The finding of the present study in contrast to these previous reports suggests that *Mucuna pruriens* action on increased testosterone could be much observed in infertile or ill healthy animals. *Mucuna pruriens* therefore appears not to trigger the action of testosterone in normal fertile bucks in spite of its effective action on sperm indices. The improved spermiograms observed in this study might be due to the presence of L-DOPA in *Mucuna pruriens* which serve as a precursor of neurotransmitter, acting as a nerviness tonic that prevents male sterility.

The effectiveness of using *Mucuna* seed powder over synthetic L-DOPA has been established by clinical trials (Hussain and Manyam, 1997). Kumar *et al*. (1994) reported that *Mucuna pruriens* is rich in L-DOPA, a precursor to the neurotransmitter dopamine, a marker of sexual pleasure (Molloy *et al*. 2006), besides having several other alkaloids and flavonoids. Therefore, reduction in abnormality following administration of *Mucuna pruriens* seed powder could be linked to high L-DOPA content of this antioxidant- rich plant (Sato *et al*. 1996). The improvement in sperm indices following treatment with *Mucuna pruriens* seed powder might probably be due to protective action of antioxidant in this plant against oxidative stress during spermatogenic process. *Mucuna pruriens* seed contains many bioactive constituents, including alkaloids, coumarins, flavonoids and alkylamines etc. which play an important role in increasing the antioxidant capacity (Misra and Wagner, 2007). Seeds of *Mucuna pruriens* also possess antioxidant, hypoglycemic, lipid lowering and neuroprotective activities (Sharma *et al*. 1978). Moreover, treatment with *Mucuna pruriens* might also contribute to proper functioning of male genital system and facilitate sperm transport (Fait *et al.* 2001). The results of the present study showed that oral administration of *Mucuna pruriens* seed powder to the bucks for 30 days did not only result in improved testicular measurements, sperm motility and sperm concentration but also led to reduction in sperm abnormality. Although the amount of nutrient intake was not measured in this study but the administration of *Mucuna pruriens* resulted in better sperm parameters measured. Muinga*et al.* (2003) reported that supplementation of diets with mucuna improved both dry matter intake and average daily gain of ruminant animals. In contrast, Chikagwa*et al*. (2009) reported that Mucuna supplementation in sheep diet reduced dry matter, nitrogen retention and crude protein intake. The difference in observation could be due to species of animal, methods of administration or processing of this plant material. The results of the present study indicated that constituents of *Mucuna pruriens* did not adversely affect reproductive functions of the bucks.

CONCLUSION

The findings from this study showed that oral administration of *Mucuna pruriens* to the bucks for 30 days resulted in improved testicular measurements and sperm motility but also maintained sperm

abnormality at a low level. On the basis of results of the present study, it may be concluded that *Mucuna pruriens* improves semen quality without any adverse effect on structure of the reproductive physiology of the bucks.

Acknowledgement

The research was financially supported by Tertiary Education Trust Fund (TETFund) through the Institute of Food Security, Environmental Resources and Agriculture Research (IFSERAR) of Federal University of Agriculture Abeokuta, Nigeria under the grant number IR**G**48/2010. The Authors are grateful to Laboratory Technologists, Department of Animal Physiology, Federal University of Agriculture Abeokuta for their technical assistance.

REFERENCES

Alo, M.N., Okeh, O.C., Anyim, C., Orji, J.O. 2012. The effects of ethanol extract of *Mucuna pruriens* leaves on aspartate aminotransferase, alanine aminotransferase and alkaline phosphatase in albino rats. Journal Natural Production Plant Resource 2 (4), 465-470.

Bearden, H.J., Fuquay, J.W. 1997. Semen evaluation. In: Applied animal reproduction. 4th ed. New Jersey: Prentice Hall; pp. 158-169.

Chikagwa-Malunga, S.K., Adesogan, A.T.,Szabo, N.J., Littell, R.C., Phatak, S.C., Kima, S.C., Arriola, K.G.,Huisden. C.M., Deana, D.B., Krueger, N.A. 2009. Effect of replacing soybean meal with Mucuna on intake, digestibility,N balance and microbialprotein synthesis in sheep. Animal Feed Science and Technology 148, 107–123.

Duncan, B. D. 1955. Multiple Range Test and Multiple F-test, Biometrics 11, 1-42.

Ezekwe, A.G. 1998. Gonadal and extragonadal sperm reserve and testicular histometry of post pubertal Muturu bulls. Nigeria Journal of Animal Production 25, 106-110.

Fait, G., Vered, Y., Yogev, L., Gamzu, R., Lessing, J.B., Paz, G. 2001. High levels of catecholamines in human semen: a preliminary study. Andrologia 33, 347–50.

Gupta, A. Mahdi, A.A., Ahmad, M.K., Shukla, K.K., Bansal, N., Jaiswer, S.P., Shankhwar, S.N. 2011. A proton NMR study of the effect of *Mucuna pruriens* on seminal plasma metabolites of infertile males. Journal of Pharmaceutical and Biomedical Analysis 15, 55 (5):1060-6.

Hamilton, T., Stark, D. 1997. Beef bull fertility, Ministry of Agriculture and Food. Fact Sheet. Queens Printer for Ontario ag.infor@omf.gov.on.ca, pp: 1-7.

Hussain, G., Manyam, B. V. 1997. *Mucuna pruriens* proves more effective than L-Dopa in Parkinson's disease animal model. Phytotherapy Research 11, 419-423.

Knight, T.W. 1977. Methods of the indirect estimate of testes weight and sperm numbers in Merino and Romney rams. New Zealand Journal of Agricultural Research 20, 291 – 296.

Kumar, K.V.A., Srinivasan, K.K., Shanbhag, T. Rao, S.G. 1994. Aphrodisiac activity of the seeds of *Mucuna pruriens*. Indian Drug 31, 321–7.

Manyam, B.V., Dhanasekaran, M., Hare, T. 2004. Neuroprotective effects of the antiparkinson drug Mucuna pruriens. Phytotherapy Research 18, 706-712.

Misra, L., Wagner, H. 2007. Extraction of bioactive principle from *Mucuna pruriens* seeds. Indian Journal Biochemistry and Biophysics 44, 56–60.

Molloy, S.A., Rowan, E.N., O'Brien, J.T., McKeith, I.G., Wesnes, K., Burn, D.J. 2006. Effect of levodopa on cognitive function in Parkinson's disease with and without dementia and dementia with Lewy bodies. Journal of Neurology, Neurosurgery and Psychiatry 77, 1323–8.

Muinga, R.W., Saha, H.M., Mureithi, J.G., 2003. The effect of *Mucuna* (*Mucuna pruriens*) forage on the performance of lactating cows. Tropical and. Subtropical. Agroecosystems 1 (2–3), 87–92.

Notter, D.R., Lucas, J.R., Mcclaughertly, F.S., Copenhaver, J.S. 1985. Breed group differences in testicular growth patterns in spring-born lambs. Journal of Animal Science 60, 622-631.

Orji, B. I., Steinbach, J. 1976. Postnatal development of testis and epididymis in the Nigerian dwarf sheep. Proceedings of the 8th International Congress on Animal Production and Artificial Insemination 3, Krakow 73-76.

Osei-bonsu, P. 1998. On-farm trials of *Mucuna* species in Ghana. In: Cover crops in West Africa; contributing to a sustainable agriculture. Ottawa, Canada, IDRC, Ibadan, Nigeria, IITA, p. 201-202.

Paul, U., Joseph, E. 2001. Effect of *Mucuna pruriens* (horse eye bean) on the gonads of male guinea-pigs. Phytotherapy Research 15, 99-102.

Perry, G., Petterson, D. 2001. Determining Reproductive Fertility in Herd Bulls. University of Missiouri Agricultural Publication G, USA.

Sato, Y., Suzuki, N., Horita, H., Wada, H., Shibuya, A., Adachi, H. 1996. Effect of long term psychological stress on sexual behavior and brain catecholamine levels. Journal Andrology 17, 83–90.

Sharma, M.L., Chandhoke, N., Ray Ghatak, B.J., Jamwal, K.S., Gupta, O.P., Singh, G.B.1978. Pharmacological screening of Indian medicinal plants. Indian Journal of Experimental Biology 16, 228–35.

Shukla, K.K., Mahdi, A.A., Ahmad, M.K., Shankhwar, S.N, Rajender, S., Jaiswar, S.P. 2009. *Mucuna pruriens* improves male fertility by its action on the hypothalamus-pituitary-gonadal axis. Fertility and Sterility 92(6), 1934-40.

Shukla, K.K., Mahdi, A.A., Ahmad, M.K., Jaiswar, S.P., Shankwar, S.N., Tiwari, S.C. 2010. *Mucuna pruriens* Reduces Stress and Improves the Quality of Semen in Infertile Men. Evidence Based Complement Alternative Medicine 7(1),137-44.

Suresh, S., Prakash, S. 2010. Effect of *Mucuna pruriens (Linn.)* on sexual behavior and sperm parameters in streptozotocin-induced diabetic male rat. Journal of Sexual Medicine 9(12), 3066-78.

Submitted October 31, 2013 – Accepted May 15, 2015