Effect of ascorbic acid on the conception rate of Yankasa ewes after estrus synchronization

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Keywords

Sheep, Yankasa ewe, estrus synchronization, progestogen, ascorbic acid, vitamin C, Nigeria

Submitted: 5 February 2016
Accepted: 13 July 2017
Published: 20 September 2017
DOI: 10.19182/remvt.31390

Summary

The objective of this study was to evaluate the effects of ascorbic acid (AA) on the conception rates in ewes following progestin treatments. Yankasa ewes (n = 64) were equally allocated into two groups. One group was treated with controlled internal drug-released (CIDR) intravaginal devices, the other with 45 mg fluorogestone acetate (FGA) intravaginal sponges. After withdrawal of progestin, ewes that exhibited estrus were further allocated into four subgroups for the administration of AA during estrus expression: CIDR control (CDNN, n = 12), CIDR plus AA (CDAA, n = 11), FGA control (FGNN, n = 13), and FGA plus AA (FGAA, n = 12). Estrus detection and natural mating were carried out with sexually active rams. The proportion of ewes in estrus did not differ between subgroups. The interval from withdrawal of devices to onset of estrus was significantly ($p < 0.05$) shorter in the FGA than in the CIDR group (30.35 ± 2.72 and 48.56 ± 7.52 hours, respectively). The duration of induced estrus did not differ ($p < 0.05$) between treatments (FGA 37.22 ± 4.22 and CIDR 39.75 ± 2.51 hours). Conception rates were comparable between subgroups. We therefore concluded that the administration of AA at sponge withdrawal did not improve the conception rate in Yankasa ewes treated with progestins.

■ To quote this article: Omontese B.O., Adewuyi A.B., Rekwot P.I., Nwannenna A.I., Rwuaan J.S., 2017. Effect of ascorbic acid on the conception rate of Yankasa ewes after estrus synchronization. *Rev. Elev. Med. Vet. Pays Trop.*, **70** (1): 9-12, doi: 10.19182/remvt.31390

■ INTRODUCTION

The estrus synchronization technique is an important management technique that has been used to improve the reproductive efficiency of sheep and goats (Abecia et al., 2012). This technique has been widely applied in temperate areas, the subtropics and the tropics. Estrus synchronization enables farmers to plan and implement genetic improvement programs, and ensure that lambing occurs when there is adequate nutrition. Sheep husbandry is a growing livestock industry in Nigeria. Nigeria has a sheep population of 22.1 million (Bourn et al., 2007). The four sheep breeds in Nigeria – Yankasa, Uda, Balami and West African Dwarf (Osinowo, 1992; Blench, 1999) – are good candidates for such techniques in order to improve reproductive management. Intravaginal progestagens such as fluorogestone acetate sponges (FGA) and controlled internal drug-release devices (CIDR) have been used to synchronize estrus in sheep and goats to that effect (Greyling and van der Westhuysen, 1980; Abecia et al., 2012; Omontese et al., 2010; 2014b). These intravaginal progestagens alter vaginal environment and cause changes in bacterial flora, accumulation of foul smelling secretions after use, in addition to an increase in the level of oxidative stress (Manes et al., 2010; Sönmez et al., 2009).

The impacts of oxidative stress on the reproductive efficiency of livestock are well documented (Ayo et al., 1996; Dobson et al., 2012). Oxidative stress alters the endocrine status, duration of estrus, follicular growth and development, and early embryonic development, all of which have detrimental effects on fertility (Fuquay, 1981; Dobson et al., 2012). These detrimental effects are often mediated by an increase in reactive oxygen species above the capacity of endogenous antioxidants to handle. Vitamin C (AA) is a potent antioxidant that is cheap and readily available (Ayo et al., 1996). Vitamin C has been reported to alleviate stress due to water deprivation, heat stress and enhance reproductive performance in ewes (Ghanem et al., 2008).

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Therefore, it is conceivable that administering AA to ewes during a breeding program may improve fertility. The use of progestagens for estrus synchronization in sheep production in Nigeria is still under investigation, and information on the effect of AA on conception rates following estrus synchronization in sheep is non-existent. Information regarding effects of AA on conception rates following progestagen treatment will be helpful in the design of an improved breeding program for sheep in Nigeria. Thus, the objective of this study was to evaluate the effect of AA administration on conception rates of progestin-treated Yankasa ewes.

■ MATERIALS AND METHODS

Location of the study

The experiment was conducted at the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Zaria, Nigeria. NAPRI is located in the Northern Guinea savanna zone of Nigeria between 11° and 12° N, and 7° and 8° E, at an elevation of 650 m above sea level, with average annual maximum and minimum temperatures of 31.0 ± 3.2 °C and 18.0 ± 3.7 °C, respectively. The region has an average annual rainfall of 1100 mm, usually lasting from May to October with mean daily temperatures ranging from 15 to 36 °C, and a mean relative humidity of 72%. The dry season lasts from November to April with mean daily temperatures of 15–36 °C, and a mean relative humidity of 20–37%. This study was carried out during the early rainy season between July and August. Mean daily temperatures recorded during the experiment ranged from 25 to 31 °C.

Experimental animals

The study involved 64 apparently healthy Yankasa ewes with body condition scores of 3.0 (BCS range 1–5; Russel et al., 1969) and aged 3–6 years. Ewes were allowed to graze within large paddocks; they were fed *Digitaria smutsii* (wooly finger grass) hay, concentrate supplement (0.5 kg/day), and water was provided *ad libitum*. At the start of the experiment, half of the ewes received EAZI-Breed CIDR (0.3 g of progesterone, Inter Ag, Hamilton, New Zealand), an intravaginal progesterone releasing device, and the other half received a sponge with fluorogestone acetate (FGA-45 mg, Chronogest, Intervet, the Netherlands) for 12 days. Ewes were placed with sexually active rams (three rams per group) and observed visually for behavioral estrus manifestation twice daily (07:00–10:00 and 15:00–18:00) for five days after progestin withdrawal. Ewes were considered to be in estrus when they stood to be mounted. Estrus response, time interval to onset of estrus and duration of estrus were observed. Ewes detected in estrus were immediately allocated to four subgroups: CDNN, i.e. treatment with CIDR alone; CDAA, i.e. treatment with CIDR plus 75 mg AA at onset of estrus (ECNU-C Injection, Yanzhou Xierkangtai Pharmaceutical, China); FGNN, i.e. treatment with FGA alone; and FGAA, i.e. treatment with FGA plus 75 mg AA. Ascorbic acid was administered intramuscularly at a similar dosage as that used in a previous study in goats (Omontese et al., 2014b). Following cessation of estrus, ewes were separated from rams. Ewes were regrouped with rams 15–20 days after natural mating to determine non-return rate of estrus. Ewes that stood to be mounted were assumed to have not conceived.

Data collection and analyses

Retention, estrus response and conception rates were expressed as percentages. Data on time to initiation of estrus and estrus duration were expressed as means plus or minus the standard error. Student's t-test was used to compare means between groups. Data were analyzed with Graphpad Prism data package for Windows. Values were considered significant when $p < 0.05$.

■ RESULTS

All ewes retained their intravaginal progestagens throughout the 12-day period of insertion. Following withdrawal of progestogens, vaginal discharge was observed in all ewes, although more foul smelling vaginal discharge was observed in ewes treated with FGA than in those treated with CIDR. Table I shows estrus response rates, time to onset of estrus and duration of estrus period following withdrawal of fluorogestone acetate sponges and EAZI-Breed CIDR devices. The estrus response was 78% and 72% in ewes receiving FGA and CIDR, respectively. Table II shows the different intervals between estruses. By day 3 post-intravaginal progestogen withdrawal, a higher percentage of ewes was in estrus in the FGA-treated group than in the CIDR-treated one. Tightness of estrus synchrony was better in the FGA group than in the CIDR one. The time from intravaginal progestogen withdrawal to onset of estrus was significantly different between FGA and CIDR groups, and was shorter in the FGA group

Table I

Characteristics of estrus expression in progestagen-treated Yankasa ewes in Nigeria

Estrus properties	FGA (n = 32)	CIDR (n = 32)
Estrus response (%)	25/32 (78%)[a]	23/32 (72%)[a]
Time to onset of estrus (hours)	30.35 ± 2.72[a]	48.56 ± 7.52[b]
Duration of estrus (hours)	37.22 ± 4.22[a]	39.75 ± 2.51[a]

FGA: 45 mg fluorogestone acetate applied on an intravaginal sponge
CIDR: 0.3 g progesterone given *via* an intravaginal controlled-release device
Values on the same line with different superscript letters differ significantly ($p < 0.05$)

Table II

Distribution of the exhibition of estrus behavior at different time intervals in Yankasa ewes, in Nigeria, following treatment with FGA-45 and CIDR

Treatment	n	Time interval (hours)				
		0–24	25–48	49–72	73–96	97–120
FGA	25	6 (24%)	13 (52%)	5 (20%)	1 (4%)	0
CIDR	23	3 (13%)	8 (34%)	6 (26%)	3 (13%)	3 (13%)

FGA: 45 mg fluorogestone acetate applied on an intravaginal sponge
CIDR: 0.3 g progesterone given *via* an intravaginal controlled-release device

than in the CIDR one (Table I). However, there was no significant difference ($p < 0.05$) in the duration of induced estrus between FGA- and CIDR-treated ewes (Table I). Conception rates were similar between AA-treated and non-AA-treated ewes (Table III).

Table III

Conception rates of Yankasa ewes, in Nigeria, administered ascorbic acid (AA) during estrus

Group	FGAA	FGNN	CDAA	CDNN
Number	13	12	12	11
Conception (%)	12 (92.3%)	11 (91.6%)	11 (91.6%)	11 (100%)

FGAA: FGA (45 mg fluorogestone acetate) plus 75 mg AA; FGNN: FGA as control; CDAA: CIDR (0.3 g progesterone) plus 75 mg AA; CDNN: CIDR as control

■ DISCUSSION

Results indicated that both intravaginal progestins were efficient in estrus synchronization of Yankasa ewes. Therefore, either progestin may be used for estrus synchronization of ewes depending on the cost and availability.

In this study, the overall estrus response was above 75%. This is in accordance with another study in Yankasa ewes following use of fluorogestone acetate sponges (Osinowo et al., 1987), as well as studies with other breeds of sheep in tropical breeding conditions (Ungerfeld, 2011; Omontese et al., 2014b). However, when compared with another study on Karakul ewes (Hashemi et al., 2006), the overall estrus response observed in this study (75.0% vs 93.3%) was lower. This might be attributed to the estrus enhancing effect of gonadotrophins administered at progestagen removal in their study, or to differences associated to the breed, location, management, season and nutritional status of the ewes (Menegatos et al., 2003; Evans et al., 2004; Ungerfeld, 2011). Although the estrus response did not differ between groups, the time to onset of estrus was significantly shorter in ewes treated with FGA than in those treated with CIDR. The shorter interval to onset of estrus in FGA-treated ewes in this study was probably caused by the differences in the rate of absorption and metabolization of each progestagen. However, this observation disagrees with the finding of Swelum et al. (2015) who reported a shorter time to estrus onset in Najdi ewes treated with CIDR or FGA during the breeding season. The mean time to onset of estrus observed in this study was 39 hours. This is similar to reports of other authors in different breeds of sheep following estrus synchronization (Hashemi et al., 2006; Omontese et al., 2014b; Swelum et al., 2015).

The duration of induced estrus observed in this study was within the ranges reported for other breeds of sheep following estrus synchronization (Hashemi et al., 2006; Ungerfeld, 2011) and it was not affected by the treatment. Duration of estrus may be influenced by the season, the breed, the type of hormone, the co-treatment with gonadotrophins, the location, the management type, the nutritional status of the animal, and the stage of the estrus cycle (Wheaton et al., 1993; Simonetti et al., 2000; Gatti and Ungerfeld, 2012).

Conception rates in this study were higher than those reported by Beck et al. (1993) and Carlson et al. (1989) in ewes treated with a combination of progestagens and prostaglandins. There was no observable difference in the conception rates of AA-treated and non-AA-treated ewes in this study. We speculate that the optimum body condition of the ewes, and the supplemental concentrate feeding in addition to the availability of lush green pasture characteristic of the early rainy season in the study area could have masked any possible effect of the administration of AA. This disagrees with the reports of Omontese et al. (2014a) in Red Sokoto goats where AA enhanced conception rates following estrus synchronization. Further studies on the effects of AA on the reproductive performance of Yankasa ewes during the hot-dry season is warranted. Other factors that may have influenced conception rates in ewes in this study include the insemination type, the hormonal treatments, the season, the nutritional status and the ram effect (Simonetti et al., 2000; Ungerfeld, 2011; Gatti and Ungerfeld, 2012).

The retention rate of an intravaginal progestagen is an important factor that can affect the efficacy of a progestagen and, ultimately, estrus synchronization efficiency. A hundred percent retention of intravaginal inserts was observed in this study. This is similar to previous reports by Omontese et al. (2010) in sheep, although, some authors have reported lower retention rates (Ainsworth and Downey, 1986). Retention is reported to be influenced by the nature of the progestagen and the experience of the technician applying the devices or sponges (Alifakiotis et al., 1982).

■ CONCLUSION

In this study, we found that i) both progestagens CIDR and FGA were efficient in synchronizing estrus in Yankasa ewes, ii) interval to estrus onset was shorter in FGA-treated ewes, and iii) conception rates were similar in AA-treated and non-AA-treated ewes.

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Résumé

Omontese B.O., Adewuyi A.B., Rekwot P.I., Nwannenna A.I., Rwuaan J.S. Effet de l'acide ascorbique sur le taux de fécondation des brebis Yankasa après synchronisation de l'œstrus

L'objectif de cette étude était d'évaluer les effets d'une administration d'acide ascorbique (AA) sur le taux de fécondation de brebis dont les chaleurs étaient induites par deux traitements à base de progestogènes. Des brebis de race Yankasa (n = 64) ont été réparties de façon égale en deux groupes. Dans l'un, les brebis ont été traitées avec un dispositif intravaginal de libération continue du médicament (CIDR). Dans l'autre, les brebis ont été traitées avec 45 mg d'acétate de fluorogestone (FGA) au moyen d'une éponge vaginale. Après le retrait des progestogènes, les brebis de chaque groupe exprimant des chaleurs ont été réparties en quatre sous-groupes : CIDR témoin (CDNN, n = 12), CIDR plus AA (CDAA, n = 11), FGA témoin (FGNN, n = 13) et FGA plus AA (FGAA, n = 12). La détection des chaleurs a été réalisée au moyen de béliers sexuellement actifs et laissés libres de s'accoupler avec les femelles. Le taux d'expression des chaleurs n'a pas différé entre les sous-groupes. L'intervalle entre le retrait des dispositifs et l'apparition des chaleurs a été significativement ($p < 0,05$) plus court chez les brebis du groupe FGA que chez celles du groupe CIDR (respectivement 30,35 ± 2,72 et 48,56 ± 7,52 heures). La durée de l'œstrus n'a pas différé ($p < 0,05$) entre les traitements (FGA 37,22 ± 4,22 et CIDR 39,75 ± 2,51 heures). Les taux de fécondation ont été comparables entre sous-groupes. En conclusion, l'administration d'AA lors du retrait des dispositifs progestogéniques n'a pas amélioré le taux de fécondation des brebis Yankasa.

Mots-clés : ovin, brebis Yankasa, synchronisation de l'œstrus, progestagène, acide ascorbique, vitamine C, Nigeria

Resumen

Omontese B.O., Adewuyi A.B., Rekwot P.I., Nwannenna A.I., Rwuaan J.S. Efecto del ácido ascórbico sobre la tasa de concepción de las ovejas Yankasa después de la sincronización del estrus

El objetivo de este estudio fue evaluar los efectos del ácido ascórbico (AA) sobre las tasas de concepción en las ovejas después de los tratamientos con progestina. Las ovejas Yankasa (n = 64) fueron distribuidas por igual en dos grupos. Un grupo fue tratado con un dispositivo intravaginal para la liberación continua del medicamento (CIDR) y el otro con esponjas intravaginales de 45 mg de acetato de fluorogestésico (FGA). Después del retiro de la progestina, las ovejas que exhibieron el estro fueron asignadas a cuatro subgrupos para la administración de AA durante la expresión del estro: control CIDR (CDNN, n = 12), CIDR más AA (CDAA, n = 11), control FGA (FGNN, n = 13), y FGA más AA (FGAA, n = 12). La detección de estrus y el apareamiento natural se realizaron con carneros sexualmente activos. La proporción de ovejas en el celo no difirió entre los subgrupos. El intervalo desde el retiro de los dispositivos hasta el inicio del estro fue significativamente ($p < 0,05$) más corto en la FGA que en el grupo CIDR (30,35 ± 2,72 y 48,56 ± 7,52 horas, respectivamente). La duración del celo inducido no difirió ($p < 0,05$) entre los tratamientos (FGA 37,22 ± 4,22 y CIDR 39,75 ± 2,51 horas). Las tasas de concepción fueron comparables entre los subgrupos. Por lo tanto, concluimos que la administración de AA en el momento de la retirada de la esponja no mejoró la tasa de concepción en las ovejas Yankasa tratadas con progestinas.

Palabras clave: ovino, oveja Yankasa, sincronización del celo, progestageno, ácido ascórbico, vitamina C, Nigeria